INTER AVIA

Review of World Aviation

In this Issue:

"Hercules" Flies

Clément Ader — South African Aviation

The de Havilland "Chipmunk" — W. Just : Helicopter Stability Calculation

ICAO and IATA Meetings — F. A. I. Record Regulations

Abolition of Airworthiness Certificates ?

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Review of World Aviation

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(F. A. I.)

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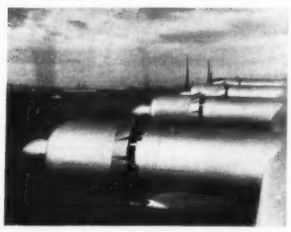

Front Cover:

Starboard wing of the Hughes "Hercules" flying-boat

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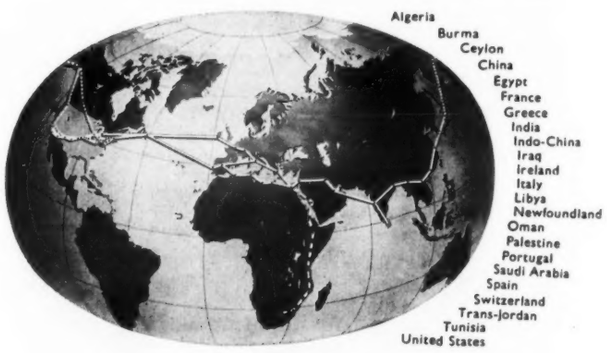

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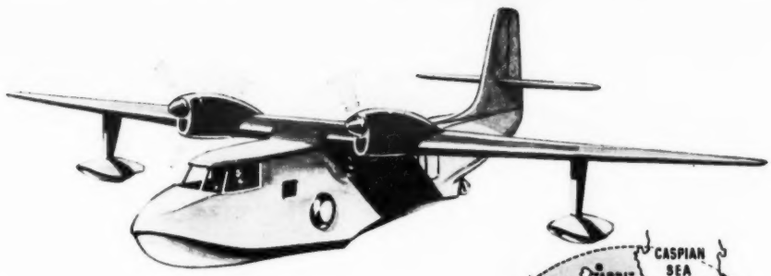

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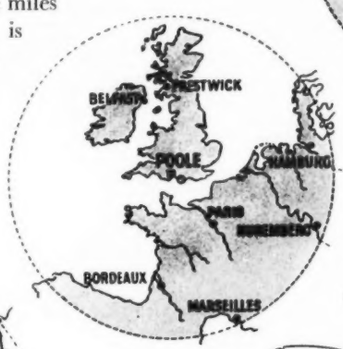

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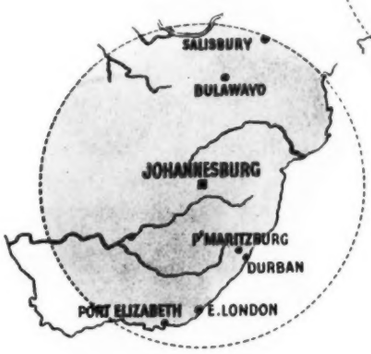

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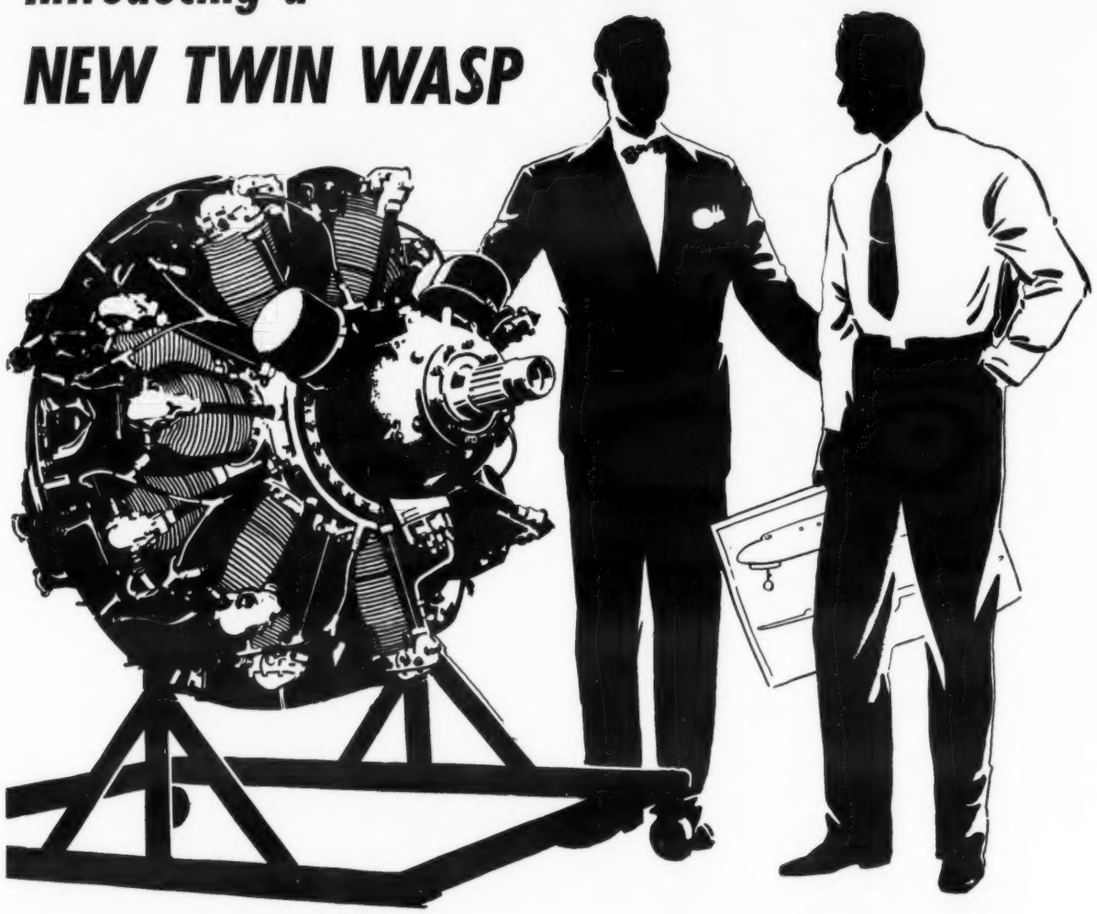

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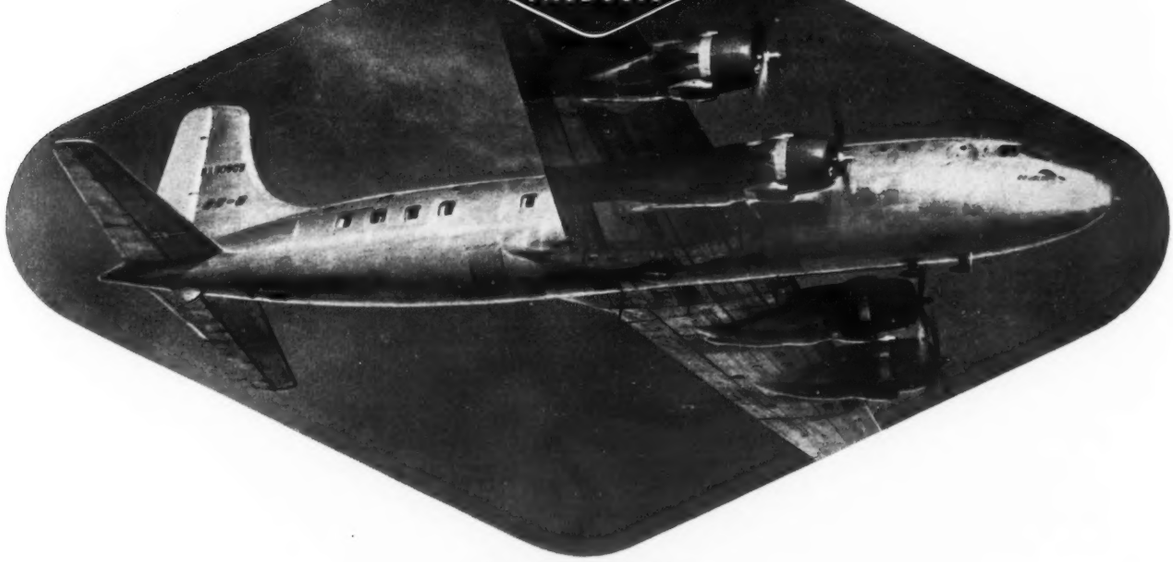

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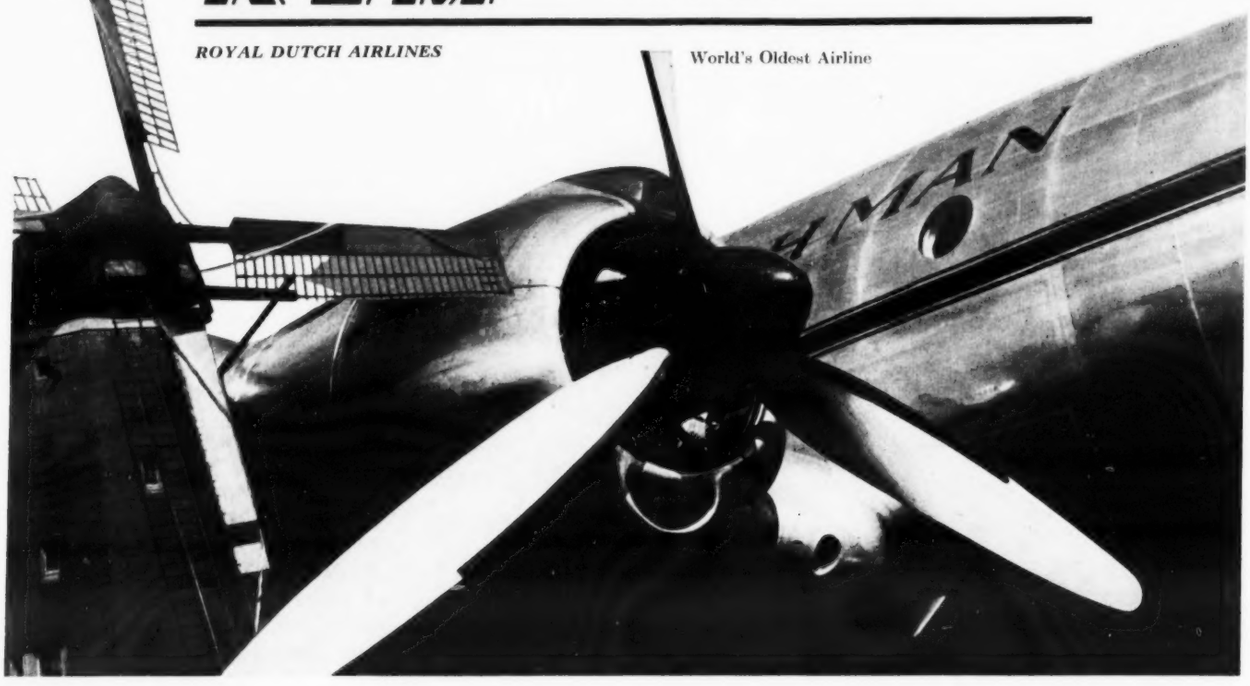

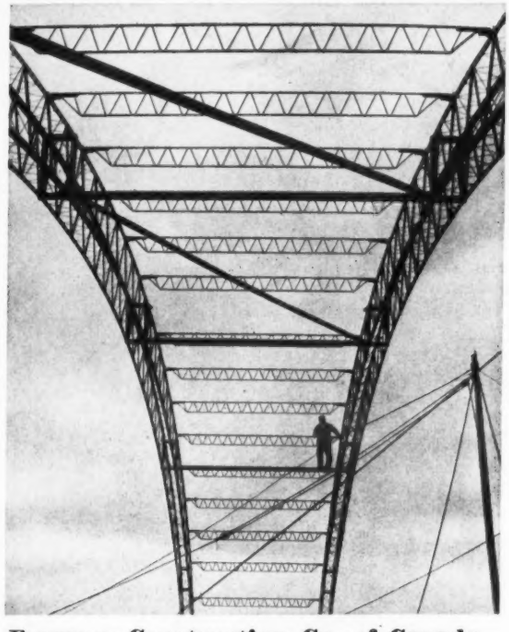

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THE EDITORS AND PUBLISHERS OF INTERAVIA

Marginal Notes

And yet it *does* move!

Have you ever assisted at a big international conference ? Probably, most readers have not ; they only know about such things from hearsay.

In principle, the prewar scene in the League of Nations building in Geneva was no different from that being enacted today by UNO in Lake Success. Men and women whom one knows only from seeing their photos in the newspapers, fly hither and thither. Persons of primary and secondary importance are surrounded by numerous secretaries, male and female, and their words of wisdom are propagated through the ether or recorded on wax for posterity. What a consumption of time, money and, so far, intellectual power, too.

A person who had witnessed such gatherings sporadically during the past twenty years, and had recently met an old acquaintance in Lake Success, would involuntarily ask what the result of it all was to be. An answer to such a question was given recently by a shrewd-witted American who is not a member of any diplomatic corps : "There are no two ways about it. This hubble-bubble is really serving a purpose, even if it does cost those taking part, and especially us, a heap of dough. You might regard it as a sort of insurance premium, and a cheap one at that. As long as these people keep on talking—no matter what about—everything's O. K. But when they stop talking, then . . ."

Don't you think he's right ? So far, UNO has not served any very useful purpose. But it has not done any harm, either. Perhaps it has been a disappointment, above all to the wide section of the public which expected certain things of it that can never be fulfilled, and other things which will still require time before they have ripened.

You may ask the reason for this background, which may seem somewhat platidudinous to the initiated.

The European Office, a branch of the United Nations Organisation, is at present using the former League of Nations building in Geneva. And for the past week in Conference Hall No. VII, the International Civil Aviation Organisation (ICAO), which became part of UNO last May, has been discussing the Multilateral Civil Aviation Agreement. As for the description given earlier on of what the UNO conferences at Lake Success look like, this most definitely does not apply to the ICAO meeting in Geneva : here, a totally different atmosphere reigns. There is no hurly-burly, no undue excitement, no mobilisation of numerous secretaries. Everything runs smoothly and to the point. Occasionally, differences of opinion are manifested a little strongly, but then there is always some calm, composed person, either the Chairman or one of the delegates, who intercedes, and everybody is quiet again. We still entertain the hope that this gathering of about one hundred representatives of twenty-eight nations may result in something productive for international unity, something useful to aviation and commerce. The aviation code of diplomacy may be a little less polished than the professional one, but its adherents are all the same good men, who know what they want.

Do you want to know why this is the case ? The explanation seems to be simple. Every meeting, every organisation and every conference may here and there reveal thoughts and opinions of the participants. But the personality at the head, leading the discussions either from the chair or from behind the scenes, sets his stamp on the entire proceedings—or else fails to do so.

This applied to the old League of Nations, and the same also applies today. As long as the Englishman, Sir Eric Drummond, was Secretary-General of the League, his intelligence pervaded both the plenary sessions and sub-committee meetings. When Sir Eric retired and was replaced by the Frenchman, Avenol, the League started going down the hill. Granted—the first Secretary-General was lucky insofar as the world at that time possessed a reservoir of real statesmen, some of whom, in Avenol's day, were dead, some murdered, and some placed on ice. But the real truth was that Avenol was no personality.

And UNO today ? The Norwegian, Tryvgie Lie, is in all probability a very good man. Meanwhile, he is faced with the superhuman task of conducting an orchestra of which most of the soloists seem to be of rather average talent, while the members of the orchestra still need to practice a little. A rather savage type of music !

As regards the International Civil Aviation Organisation, the situation is more favourable. A tall, thin, composed man with a high forehead and eyes which reflect human decency besides intelligence, holds the ropes. Scientist, one-time U.S. Under-Secretary of the Navy for Air, for many years aviation consultant and member of government organisations, Dr. Edward P. Warner is backed by the necessary practical experience to make him the right man for the job. For this reason the goal may be achieved, even if certain members of the orchestra sometimes try to play individual tunes of their own, and although an important soloist has so far refused to co-operate.

To take the bull by the horns, we might venture to say that the whole affair—aviation, namely—must once and for all be put in order. What is happening today cannot go on for ever. Why not ?

We read, for instance, that the British nationalised airlines, apart from subsidies, are year by year suffering deficits of several million pounds sterling. Furthermore, we read that the U.S. domestic airlines, operating the densest network in the world, reported a net operating income of about $13,000,000 for the 1945-45 fiscal year, and a net operating loss of some $22,000,000 during the 1946-47 period. Where is the money to come from if this continues much longer ? That the number of passengers increased by 20 per cent. and freight revenues by 300 per cent. during this period may all sound very fine. But the operating expenses have risen far more sharply and will probably amount to something like $550,000,000 for 1947. And such a sum is already significant from the standpoint of *world* economics.

President Truman has now established his Air Policy Commission for the purpose of introducing order in this connection. And a spokesman of this commission recently called for "a national transportation system" in which all forms of transportation could co-operate to eliminate "destructive competitive wastes."— Awfully simple !

Co-operation of all forms of transportation, when such co-operation has not yet been achieved in the one form of transportation in which we are interested ? This is the very problem at present being discussed in Geneva, the problem concerned in the ICAO negotiations for a multilateral agreement between the various airfaring nations.

The Yankee would say : "It's plum crazy !" Shakespeare expressed it more classically : "Though this be madness, yet there is method in't." ICAO decided to become part of UNO and, *nolens volens*, a technical body became mixed up with politics. In order to conform to the UNO statutes, it had Spain ejected last May. This constituted an act of obeisance towards the East. But Russia, a member of UNO, has chosen to ignore it, and has so far refused to have anything to do with ICAO and international civil aviation. Some people may perhaps think that this makes ICAO's task a lot easier. Perhaps . . . But ICAO is only a means to an end ; from the viewpoint of commercial progress, deeds are more important than prestige. And Russia's not being a member does not prevent us from flying, but it makes it impossible for us to use the term "world aviation" in its real sense.

It is a case of Hobson's choice ; and such thoughts do not come to mind merely because ICAO happens to be meeting here in Geneva, but also because the ICAO conference nearly coincides with the brilliant celebrations in Moscow of the Soviet Union's thirtieth anniversary.

May we take the liberty of reminding the Soviet Union of the words of Galileo : *"Eppur si muove !"* . . . And yet it *does* move !

EEH.

A peep into the conference hall where ICAO is discussing the Multilateral Agreement—November, 1947, in the Geneva Palais des Nations.

Ink or Fuel?

Two World Aviation Organisations: ICAO and IATA at Work

Everyone is of the opinion that world aviation is perhaps more dependent on international co-operation than any other branch of commerce. As for the best methods by which the nations should co-operate, there is less unanimity of opinion. Experience has shown that when it comes to examining concrete circumstances and working out practical measures, the international concert tends strongly to break into a cacophony, towards which each separate musician contributes by sticking rigorously to his own particular tune.

It is far from being our intention to criticise from this angle the successes achieved by the two major organisations in world aviation, the government-run International Civil Aviation Organisation and the privately-financed International Air Transport Association. But we could understand the heterodox thought that, in the field of economics, the compulsion to earn money is a more active stimulant than the granting of attorney-powers by just any community, whether the latter be a State or an international body.

Still discussing... the Multilateral Agreement.

The July issue of *Interavia* contained a description of ICAO at work. Perhaps readers found the results of the First Assembly, from May 6th to 27th, 1947, somewhat meagre. Most noticeable was that the draft Multilateral Agreement failed to emerge from the committee stage.

Meanwhile, it is obvious that it could not be settled during the course of just one meeting. One had to give heed to the reactions of those who want to see aviation run on fuel—not ink. Airline companies, air freight carriers and passengers had been awaiting—with the patience of bureaucratic laymen—fundamental explanations ever since the Chicago Conference of 1944. They knew that, *in practice, airlines have the right to fly over the territory of a Contracting State and to make non-traffic landings (Freedoms 1 and 2).* They were aware that *the nations have been in dispute for three years over the question of whether the remaining three Freedoms should, or should not, be granted on a multilateral basis,* i. e., whether the airline companies of all the Contracting States should be empowered to transport passengers, mail and freight:

1) from the aircraft's State of registration to the territory of another Contracting State (Third Freedom);
2) from the territory of a Contracting State to that of the aircraft's State of registration (Fourth Freedom);

At the President's table (left to right): Dr. Edward P. Warner, President of ICAO; Professor E. Amstutz, Swiss Chairman of the Meeting; R. J. Moulton, Deputy Chairman of the ICAO Air Transport Committee.

Head of the United Kingdom delegation, W.C.G. Cribbett (left front), and his fellow-delegates.

The third Annual General Meeting of the International Air Transport Association at Quitandinha, near Rio de Janeiro.

3) to and from any Contracting State (Fifth Freedom).

But the public as well as most Governments had become sick and tired of commentaries. They wanted decisions.

Hence it was resolved to bring up the Multilateral Agreement at a special conference of ICAO States, which was to have taken place in Rio de Janeiro last October.

Instead of the sunny month of October in Rio, however, final choice fell upon the misty month of November in Geneva. But locality, season and circumstances should not count, if multilateral agreement is achieved. If not ?—The President of ICAO, Dr. Edward P. Warner, declared at the preliminary press conference that, if they failed to reach such agreement, then *2,400 separate bilateral pacts would be necessary if world aviation were to proceed on a fairly orderly basis.* To avoid all this complication, *why not have one single document ?*

Whilst these words are going to press, the delegates of the ICAO countries are in session at the Geneva Palais des Nations. By the time this magazine is in circulation, the question will have become settled. We cannot prophesy the outcome, but we can only observe that the ranks of the fighters for unreserved granting of all Five Freedoms have grown thinner. Canada, for instance, was one of the staunchest supporters of the Multilateral Agreement last May. Today, she has submitted an adjustment proposal which is almost tantamount to a rejection of the Fifth Freedom. The precise words of one sentence are :

> " It is unfortunate, but nevertheless true, that civil aviation has not yet reached a point where it seems possible to achieve an agreement covering a multilateral exchange of all traffic rights. "

True, but nevertheless unfortunate . . .

It can also be otherwise . . .

Last October the *third Annual General Meeting of the International Air Transport Association* was held at the Hotel Quitandinha, near Rio de Janeiro. The most spectacular results of this Meeting were achieved at the joint Regional Traffic Conference sessions, which preceded the actual General Meeting. Whereas IATA Traffic Conferences used to comprehend nine regions, they have now been restricted, for simplification and economy reasons, to three : Conference No. 1—North and South America ; No. 2—Europe, Africa and the Middle East ; and No. 3—Asia, the East Indies and Australasia.

The office of the IATA Meeting in Rio de Janeiro (left to right) : Chairman of the IATA Executive Committee, Paulo Sampaio (President of Panair do Brasil) ; 1947 President of IATA, Dr. J. Bento Ribeiro Dantas (Cruzeiro do Sul) ; Sir William P. Hildred, IATA Director-General.

The representatives of 69 airlines from 42 countries held their meeting in one of the most spectacular settings imaginable—Quitandinha, located in the mountains above Rio and in terrain that looks as though the Hand of God has crumpled the earth like a piece of paper. But the delegates could not be lured from the conference table. Many of the participants never left the hotel at all during the sessions ; and although there were three weeks of almost continuous day and night work, a substantial number never even got a glimpse of Rio, except on the way to and from the airport.

The *success of the Meeting* can be sketched in very few words, since it was substantial :

Agreements of unprecedented uniformity were reached, which will considerably speed service, simplify passenger handling and cut red tape on the 500,000 miles of routes operated by the airlines of 42 countries :

> By July 1st, 1948, standard tickets, baggage checks and conditions of carriage will be introduced for all companies and countries.
>
> *
>
> A uniform basic shipping document for air cargo will be established.
>
> *
>
> An air travel credit plan is to be introduced, by which the passengers of most countries will be able to pay for their trip with credit cards. It will be geared to the operations of the IATA Clearing House.
>
> *
>
> The normal validity of airline tickets has been set at one year on all routes, except on short-haul services where tickets will remain good for six months.
>
> *
>
> Rates will remain virtually unchanged throughout the winter, except for a rise of one half cent per mile on the North Atlantic route, due to the continuously rising costs of operations.

*

In assessing the work of the joint conference sessions, Gordon R. McGregor, General Traffic Manager of Trans Canada Air Lines and Chairman of the joint meeting, asserted :

> " This unprecedented degree of uniformity is as important to the public and the airlines as the standardisation of gauge on the railways. "

It can also be like this . . .

He.

Through Disappointment to the Final Goal

Clément Ader - The First Teacher of Modern Aeronautics

Fifty years ago, on a frosty and misty October day in 1897, a military commission, shivering with cold, left Paris for the shooting ground at Satory to witness the first flight of an aeroplane. The attempt was unsuccessful, the aeroplane was badly damaged, and everyone hastened away from the shooting ground except one man, to whom the military officials all but omitted to address a few banal words of farewell.

In 1925, the members of that commission who were still alive, dutifully participated in the funeral cortege of the pilot they had scorned in 1897. It was the funeral of Clément Ader, constructor and aeronautical theorist.

This year France celebrated the 50th anniversary of his first attempt to fly ; and we propose in this article to justify to some extent the importance of Ader's work to aeronautics. *The Editor.*

A Magician ?

The surface of these runways will at least be macadamised, or perhaps treated with asphalt, or paved with wooden blocks. It must be kept extremely clean and special provision must be made to assure that rainwater is properly drained off. In case aeroplanes should undertake night flights—perhaps these will be no less seldom than flights by day—the edges of the runways must be illuminated with torches of special colours, which must be sunk into small holes in the ground, at sufficient distance apart, and closed off at ground level by wire netting . . .

These words appear to be anything else but sensational, since they describe broadly the runway set-up of any airport. It is only a few lines further on that our attention is claimed :

. . . Later on, use will be made of telegraphy, as soon as this latest invention had been sufficiently developed and its methods can be put into practice . . .

Hey ! Just a minute ! Telegraphy, the latest invention ? We turn back from page 18 to the title page of the book, and read :

C. Ader
L'Aviation militaire
Troisième édition, revue et corrigée
Berger-Levrault, Editeurs
Paris Nancy
1911

The manuscript of this book on military aviation was written between 1897 and 1920. The material for it had been collected since the 80's of the last century.

Now we really have reason to be astonished. We feel very definitely that we are entering the realm of unreality. Line by line we are convinced of this. We read of "steel arrows," "torpedo aeroplanes," and of "releasing bombs" ; of "reconnaissance aeroplanes"—whose speed would constitute their sole armament—of portable "campaign runways made up of wooden panels which could be fitted together," of "vertically-firing artillery," and of "aircraft carriers."

Clément Ader at the age of 25.

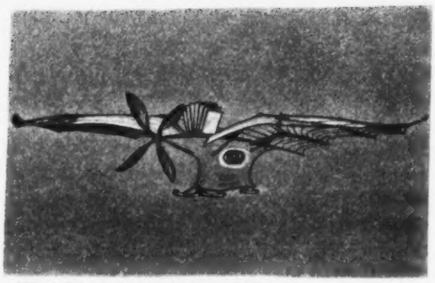
You will recal that it was in 1911 when an aeroplane took off from a ship for the first time, and that the superstructure of the British cruiser "Africa" was not subjected to any great modification on this occasion. A launching ramp comprising two rails, built at Chatham Docks, was simply mounted at the stern of the ship. We must first of all visualise this before we can fully appreciate the significance of what Ader wrote around 1895 :

. . . Thus, an aircraft-carrier becomes indispensable. These ships will be built according to plans very different from those at present in existence. First of all, the deck must be free of all obstacles : flat, as wide as possible without being to the detriment of the nautical requirements, it will feature all the aspects of a runway. The word 'atterrissage' (landing) is perhaps not appropriate, since everything will take place at sea ; let us replace it with the word 'abordage' (deck landing) . . .

The hangars will, of course, have to be below deck . . . Access to these will be provided by lifts, large enough to accommodate an aeroplane with folded wings . . . Alongside the hangars will have to be the workshops where necessary repairs can be executed and the aeroplanes constantly kept ready for flight . . .

Unbelievable . . . We might be inclined to suspect a mystification, a later forgery of a text which had been "re-arranged," and not even very adroitly, if it were not for the fact that history reveals Clément Ader's life to have been one of absolute integrity. Ader built the first powered aircraft in the world, not only in model form, but full scale. He was completely lacking in those qualities common to the great "illusionists." The characteristic trait of those people is notorious : even if their creations are imperfect or technically useless, they are so adept at "mystifying" their contemporaries that these still continue to believe in them, even when their lies have long been exposed and their theories proved to be entirely wrong. No ! Ader was not a "magician." It was never his intention to vindicate his ideas and convince his fellow men of the quality of his inventions. Even when he had built and demonstrated an aeroplane capable of flying—whether he really flew is not the cardinal point—the answer he received was a brutal and inexorable "No." The most

Title page of "L'Aviation militaire," by Clément Ader.



The "Eole," Ader's first aeroplane.

convincing of circumstantial evidence was of no value in his case : it could not be accepted because "it could not be true."

Through disappointment to the final goal

If we wished to find an epigraph for Ader's life, we could not find a better one than the title of this article. A recently published biography, "L'homme qui donna des ailes au monde," by Louis Castex (Published by Plon, Paris, 1947) eloquently traces the inventor's sorrowful life amidst the jungle of human incomprehension.

In his struggles with hostile Nature, Ader the technician, despite the rudimentary means at his disposal, always emerged as the victor. When he had to do with Man, he was invariably the loser. Take, for instance, his first aeroplane, the "Eole." There were no combustion engines at that time. Consequently, Ader built a steam engine which weighed, dry, about 100 lbs. and developed 20 H.P., thus about 5 lbs. to each horsepower, which was a remarkable achievement for those days. The era of light alloys had yet commenced. But this did not worry Ader in the least. He built his airframe of wood, making the members hollow like birds' bones and re-inforcing them with adhesive layers of cloth.

This manner of treating the wood bears witness to Ader's manual skill. Incidentally, he spent his early youth in a carpenter's shop which his father ran in Muret (Haute-Garonne), where the young Ader was born on April 2nd, 1841. A certain skill for manual work is common among all classes of the Southern French. Notwithstanding the fact that the intellectual level is higher in the south, the population has remained closer to Nature than the people of the more northern regions of France.

At the age of twenty-one, Ader entered the service of the "Ponts et Chaussées," the State administration for civil engineering. Alongside his profession, which he exercised with enthusiasm and success—there is a railway bridge at Muret to his memory—he revealed himself to be a tireless inventor—and suffered disappointment upon disappointment.

Nearly all Ader's inventions followed the same road—from nocturnal toil at the drawing board to the model, then to a stern refusal, and finally to the Conservatoire des Arts et Métiers in Paris. Whether it concerned the first bicycle to be fitted with rubber tyres, or his improved telephone, or the particularly powerful under-water cable, the world's reply was invariably the same as that which War Minister Niel gave when Ader offered him the first caterpillar vehicle and drew his attention to its suitability for travelling in the desert or on soft soil : "... It is not worth testing from the standpoint of its usefulness to military operations."

As a matter of fact, the only invention for which Ader really received universal recognition was for something which could not even be patented. He installed a microphone back-stage at the Paris Opera House and transmitted the performances telephonically to a hall equipped with forty hearing apparatuses. It is ironical to think that it was for this toy, the "Théâtrophone," that Clément Ader was awarded the Order of the Légion d'Honneur, on December 29th, 1881.

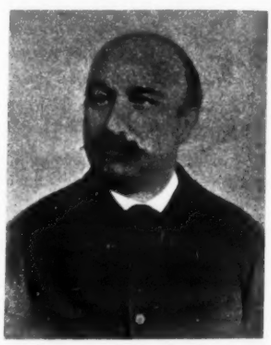
Ader's Aeroplanes

Leonardo da Vinci designed the first airscrews and, in his sketches, he equipped many of his flying machines with bats' wings. In 1784, Launoy and Bienvenu, two Frenchmen, built a model helicopter which furnished results of pratical value. The Englishman, Henson, patented in 1842 the model of an aeroplane which was to be driven with steam. And the steam engine of the model monoplane built by Stringfellow in 1838 is perhaps the most convincing piece of miniature work ever known as regards applying a steam engine to power an aircraft. Similarly, Mouillard and d'Amecourt may also be regarded as forerunners of Ader.

But all the same we may affirm with clear consciences that it was Clément Ader who built the first aeroplane which could be stated to have something other than the mere name in common with our present-day "heavier-than-air" aircraft.

His work cost him a great deal in the way of toil and money : and he never possessed an excess of the latter commodity. From the top of Strasbourg cathedral, he used to watch the storks flying. In Algeria, near the bridge of El Kantara, he used to attract vultures with a basket-full of meat in order to wrest from them the secrets of how they glided on up-wind currents. And at the small house which he bought in the rue de l'Assomption, Montmartre, which constituted his first Paris workshop, he set up large cages where he kept all kinds of birds, from canaries to eagles and huge Indian bats, in order to study their methods of flight and thus build up his theories.

The "Eole," begun in 1882, was tested in 1890 in all secrecy on a track erected in the grounds of the Chateau d'Armainvilliers, which Madame Péreire had kindly placed at his disposal. Did Ader's first flying machine really take off on October 9th, 1890 ? His two assistants and the gardener to the Péreire



Clément Ader in 1890.

family were there as witnesses. Madame Péreire herself, against the wishes of the inventor, had watched the experiment through the drawn curtains of her window. She, too, maintained that the "Eole" did not touch the ground for a distance of at least 150 feet. Notwithstanding the differences of opinion which reigned at the time, the French War Ministry began to take an interest in this engineer with a passion for flying. War Minister de Freycinet had the machine demonstrated to satisfy his own curiosity ; and for the next seven years, Ader's work was backed by the State. He called his second project an "Avion," derived from the Latin word "avis," meaning bird, and thus created the modern French equivalent for the word "aeroplane."

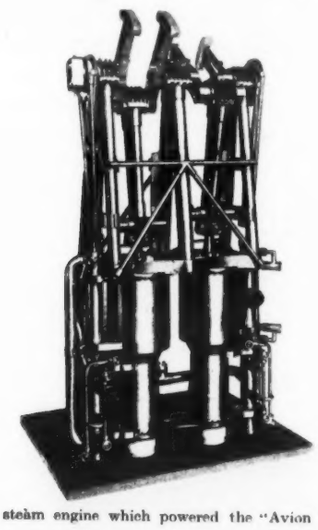
"Avion No. 1" was followed by "Avion No. 2" and "No. 3." The trials of the latter version, which is today on exhibition in the Paris Conservatoire des Arts et Métiers, marks the termination of Ader's practical experiments. This undertaking also ended with

The "Avion N° 3". Did it become airborne at Satory ?

brutal suddenness. On October 12th, 1897, Ader demonstrated his "Avion No. 3" before a military commission at the Satory shooting ground. On October 14th, 1897, the inventor attempted a second test flight, despite the presence of strong autumn gusts. The aeroplane was blown off the track and smashed up against the wooden fence surrounding the field. *Having lost all confidence in Ader, the military authorities refused to grant any further assistance. Ader then engaged a certain Mr. Boiret, a packer who lived in Passy, to destroy everything in his workshop, including the "Eole" and the plans which he had not yet sent to the War Ministry. He personally watched this work going on and insisted that every single souvenir of his fifteen years of work and hopes should disappear.*

But in him we find none of the elements of misanthropy which drove more than one author to destroy his manuscripts, nor of the indifference with which Michael Angelo, for example, allowed his sculptures and plans to rot away in studios scattered all over the country. Ader went back home to Muret, began again from where he had started, wrote up his theory of military aviation, and formulated his prophesy—which has only recently been justified : *Sera maître du monde, qui sera maître de l'air.*

A further and perhaps more convincing example of his indomitable courage : the Wright brothers had arrived in Europe from the U.S.A. and were honoured as the "inventors of the aeroplane." Ader kept silent. But when the "Société Ariel," a shareholding company founded by Lazare Weiller (the father of Paul Louis Weiller), attempted to stop the young French generation of fliers—Farman, Voisin, Blériot—from flying and constructing because certain patents owned by the Wright brothers excluded all competition, Ader emerged from his reclusion and unselfishly offered his support to the young aviators in trouble. He proved that the patent which he had taken out on April 19th, 1890, invalidated the claim made by the Société Ariel. Weiller maintained that "gauchissement" (warping) was forbidden ; but this was ridiculous, since the words "gauchir" and "gauchissement" were contained in Ader's patent. Indeed,



The steam engine which powered the "Avion No. 3".

Special stamp issued by the French association, "Ailes brisées," to celebrate the 50th anniversary of Ader's flight attempt at Satory.

they discovered even more—these terms had actually been created by Ader. And to prove everything, the "Avion No. 3," exhibited in the museum, was still there to bear witness. The Société Ariel was nonsuited and Ader returned to Muret, his purse considerably lighter. He had borne the entire costs of the case, although the people he had helped had been complete strangers to him.

Curiously, a similar court case was taking place almost simultaneously in Germany. Like Nature, history is rarely content to execute a theme only once, but prefers to compose it in the most diverse variations. In Germany, the Wright brothers had taken out a patent to protect their system of coupling the warping with the rudder. In this instance, too, they tried to prevent all competition and to assure themselves a monopoly as regards construction. At this stage, yet another unacknowledged inventor became entangled. Friedrich Robitzsch, an officer, had deposited a patent in 1902 for an aircraft incorporating warping. He, too, had offered his patent to the War Ministry, and had had it refused. And, moreover, he also had encountered, amidst the private people whom he tried to interest in his invention, nothing but incomprehension and refusals. Robitzch's own patent became public property, but in the case of the Verein Deutscher Flugtechniker versus the Wright brothers, he obtained his rights in that warping, even in combination with the rudder, was declared free to all. As the costs of the case were divided among the litigant parties, he had to contend with heavy losses.

There is no intention here to sow any seeds of doubt as to whether the Wright brothers really did invent the aeroplane, or to brand them as usurpers of this honour. They, too, burned the midnight oil and made their discoveries at a cost of unceasing toil and danger. Moral : the aeroplane was not invented by an individual ; it is humanity which created wings for itself.

Still unacknowledged ?

The question of whether Ader flew in 1890 and 1897 has been a subject of hot controversy for many years in France. Georges de Manthé, Ader's son-in-law, had a book published by Editions Privat-Didier, "Le Père de l'Aviation," in which he set himself out to prove that Ader was the first man to become airborne in a heavier-than-air aircraft. The well-known journalist on motoring and aviation, Jacques May, fought energetically for Ader's recognition, and finally obtained, in an interview, a statement from old General Mensier, a member of the commission which witnessed the trials in 1897 at Satory. The sceptics started calming down gradually. But Ader was a very old man, and almost at death's door, when he was finally rewarded with the honours due to him, which had always been refused him during his youth. On the occasion of the banquet in celebration of nomination as Commandeur de la Légion d'Honneur, in 1922, Clément Ader pronounced a sentence which was tantamount to an adjuration, and which has repeatedly been addressed in vain to all men since the beginning of time : "Be not too proud to open your eyes before the truth . . ."

This gentle warning to humanity applies particularly well to his case today. There is every evidence that Ader has not yet been understood completely. The never-ending controversy as to whether he flew or not—and sceptics in France are again putting forward seemingly weighty arguments—do not affect Ader at all. These people utterly fail to comprehend his real value as an individual.

The light of a man who, in the years from 1860 to 1900, established a comprehensive theory on aviation, describing line by line the " Battle of Paris " in a chapter devoted to

Ader aged 80.

manoeuvres, long before Giulio Douhet ever wrote a word, and who in 1897 built the aeroplane with folding wings now in the Paris Museum, cannot be placed under a bushel by petty historical squabbles. The monument which he has acquired in aviation will long outlast that which his fellow-citizens have erected to his memory in Muret. It seems that aviators must do themselves harm by continuing to disregard his real merits and to make his glory dependent on the pitiful controversy as to whether the " Eole " and the " Avion " really became airborne or not. " Be not too proud to open your eyes before the truth. "

He.

P. S. — The stamp alongside the title of this article, and the special stamp, were lent by the "Ailes Brisées" association, which exhibited various souvenirs of Ader — bicycle, telephone, steam engine, etc. — at the Musée Galiéra in Paris from November 11th to December 1st, 1947. The special stamps were used for airmail despatches over long-distance Air France routes, and can be purchased from the "Ailes Brisées," 9, rue Daniel Lesueur, Paris 7e.

Variations on Two Wheels

Not very long ago I bumped into an old school chum, who informed me, to my surprise, that he is now a captain on the France—South America air route.

Lest there should be any misapprehension, allow me to make it quite clear that I met him on *terra firma,* and not by any chance on board his airliner. It so happens that my aeronautical experiences are limited to ten minutes of being airborne, in 1931, in circumstances which I have already related to *Interavia* readers : the only instance in which my equilibrium was really imperilled was after the landing, and this because the barman at the airport restaurant had displayed an excess of zeal in his efforts to restore my *sang froid.*

Getting back to the subject of my school chum, he could talk of nothing else but his job, which he liked exceedingly. Incidentally, he is no braggart ; pilots seldom are. He just makes two round trips a month to Buenos Aires with his forty-odd passengers and crew members, and is no more unnerved about it than you or I would be about taking a stroll around Montmartre or the Place de l'Opéra. It is pretty obvious from his yarns that he has all the same to contend with plenty of hardships, such as leaving Paris with the temperature at 22 degrees of frost and, without leaving the controls for twelve hours, arriving at Dakar where the thermometer is nearly up to 100 deg. F.

"The thing that bothers me most," he said, "is that I never know what to do with my overcoat when I get there."

I asked him whether he ever got scared.

"Scared ? What is there to be scared about ? Well, I suppose my passengers do sometimes feel a little uneasy when we run into an air-pocket. But I usually tell them that now isn't the time to be scared ; when they'll need all their courage is during the bus ride from the airport into town."

And, thereupon, this "tough guy" frankly confessed to me that he is invariably scared to death when riding in one of the buses which ply between the South American airports and cities. In Rio de Janeiro, it appears, the bus and taxi drivers make it a point of honour to drive as fast as possible and to pass every other driver on the road. And seeing that all motorists in Rio seem to abide by the same code, one might very well ask whether the chauffeurs, instead of taking the route indicated, would not find it a lot simpler to branch off and head straight for the cemetery, without further preliminaries.

"On the last trip I made," my friend related, "my driver got it into his head to follow the tramlines at top speed—just a little idea he conceived on his own. He went shooting along at at least seventy, his foot well jammed down on the accelerator and his eyes glued to the rails. Meanwhile, he failed to perceive that, at one point, the tramlines left the road level to form a kind of overhead track. Luckily, the wheels of the taxicab just fitted the gauge of the tramlines ; but all the same we travelled a good hundred yards under these highly-unpleasant circumstances. When we came down to earth again and the rails had once more resumed their original position, my driver blushed red with delight ; but I think I must have been green with trepidation. Happily, my prestige was spared, since my travelling companion, a Brazilian, hadn't noticed a thing."

"How come ?"

"Well, you see, he was colour-blind."

Despite all my friend's words of comfort, I am still chary of travelling by air. And as for automobiles, my opinion has long been unshakeable : the most miserable and fear-inspiring invention of the century.

The only decent means of transportation, the most agreeable and delightful vehicle of all, in my opinion, is the bicycle. Thank Heaven for my bicycle ! I never use anything else for running around Paris. I find it positively intoxicating to weave my way through traffic jams, passing cars in trouble, merrily whistling as I exchange knowing glances with fellow cyclists who can also afford to turn their noses up at the vile odours emanating from the fuel-propelled monsters around us.

And out in the country ! You don't miss a single detail of the landscape, not a single patch of colour ; the slightest noise is audible : the lightest breeze in the trees, the song of a faraway bird, the smith's hammer striking the anvil in the next village, the distant tinkle of a piano as a child practices its scales. These are all riches which are denied to the motorist. And it serves him right. If he prefers the din of his engine, the scraping of his gears, and the splutterings of his carburetor, well he is welcome to it. Personally, I don't envy him at all.

In reality, when I'm on my bicycle, I feel more closely related to the aviator than to the motorist. By adhering to the philosphy of Bacon, who said something about its being better to have lead soles to one's shoes than to have wings, I find that the bicycle and the aeroplane, and the cyclist and the pilot, have a great deal in common.

Of course, I know you will argue that the aeroplane's wings are a symbol of liberty and independence, and that the endless chain of the bicycle, in contrast, is significant of eternal torment and of our never-ending slavery to life's conventions. Granted ; there is indeed a considerable difference in this connection. But I ask you to consider this very point from another angle : don't you agree that the bicycle reflects our present-day calamities far more faithfully than the aeroplane does ?

On the other hand — and I call to witness all who use both aeroplanes and bicycles — aren't the joys of engineless flight exactly the same as those of free-wheeling ? Again, isn't it with the same unconstraint that both the aviator and the cyclist defy the law of gravity ?

Finally, as a careful owner of a bicycle, I regularly pump up my tyres. Thus, they are filled with air.

Under these conditions, have I not every right to describe myself, with justified pride, as being "heavier than air ?"

Yves Grosrichard.

Some French Aircraft Types now in Production

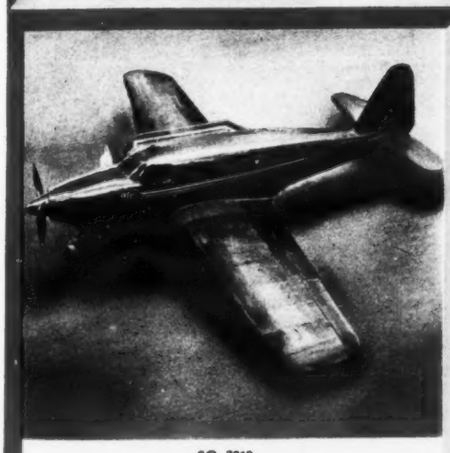
C. 800 GLIDER
Two-seater trainer

NORD 1200 "NORÉCRIN"
Three-seater personal aeroplane.

BREGUET 11E HELICOPTER

MORANE-SAULNIER 472
Two-seater fighter trainer.

SUC 10 "COURLIS"
Taxi or personal aircraft.



SO 7010
Taxi or light transport aircraft.

NC 702
Eight-passenger transport aeroplane.

SO 30 R
Modern 30-passenger airliner.

LANGUEDOC 161
Four-engined-53-passenger airliner.

LATÉCOÈRE 631
72-ton flying-boat

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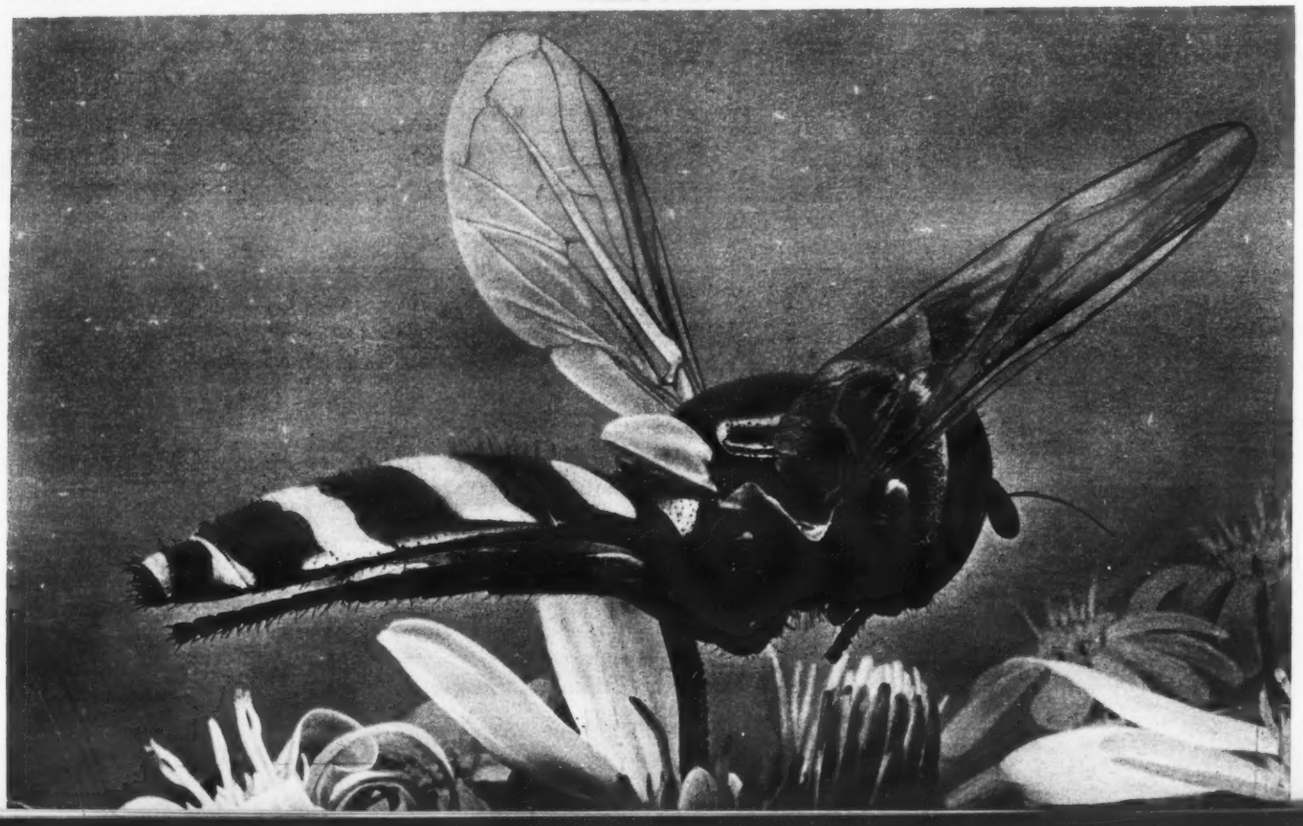
On Drone Flies, Gyroscopes and Balancers

Ready to photograph the wing action of a drone fly at 3,000 frames per second, with a high-speed camera and continuous flash lighting unit. The thin rod stuck to a wad of wax on the fly's back permitted free movement of the wings and halteres.

Rotating parts are a characteristic of devices and machines conceived by Man ; tens of thousands of species of living creatures only possess organs which move to and fro, or turn through angles of less than 360 degrees. All the same, it has been established that, from the point of view of economy, the wheel is superior to the leg, the centrifugal pump to the heart, the turbine to the muscle and the airscrew to the birds' wings. It must be remembered, meanwhile, that rotating organs have no bodily connection with their bearings, that they cannot maintain the living body's " inspection and repair system " which is active during the " operating period, " and that they must therefore be constituted of dead material, which is liable to wear and tear. For this purpose, Man has invented the delightful practice of " periodical overhauls, " with which he surrenders a good part of the economy he has gained : from time to time he must allow his equipment to rest, in order to replace the dead material of the worn-out parts, or even replace the parts entirely.

Modern engineering has produced yet another rotating element, in the design of which surely no analogy to Nature was meant : the freely-suspended gyroscope which, revolving at high speed, endeavours to retain its axis direction in space and thus provides a reference system for aircraft navigational instruments, control and aiming devices. Meanwhile, this organ is not altogether perfect either ; it

Enlarged scale model of the drone fly, showing the rod-and-ball type balancers or halteres behind the wings.



fails if subjected to quick turning motions, or if its indications are required over very long periods. As it happens, the greatest worry is not caused by the wear and tear of the bearings, but by the source of all wear and tear—friction. Frictional forces hinder the free setting of the gyroscope and indirectly impair its directional accuracy.

In their search for improvement, the Sperry Gyroscope Company, Inc., of Great Neck, N. Y., turned to Mother Nature. Does not the flight of the common drone fly embody the ideal ? Its extreme manoeuvrability is manifested in the manner it eludes pursuers, by rapidly changing its direction of flight, without ever losing its sense of orientation or its ability to counter-balance all stability disturbances.

The housefly, or drone fly, is a two-winged insect belonging to the order *Diptera,* which numbers some 50,000 species. Behind the wings is a pair of tiny rod-and-ball type devices, called balancers or halteres. It has been known for a long time that these organs play an important part in the stability and control of the fly's flight. Deprive the *Diptera* of one or both of their halteres, and their flight becomes uncontrolled, ending in a crash landing.

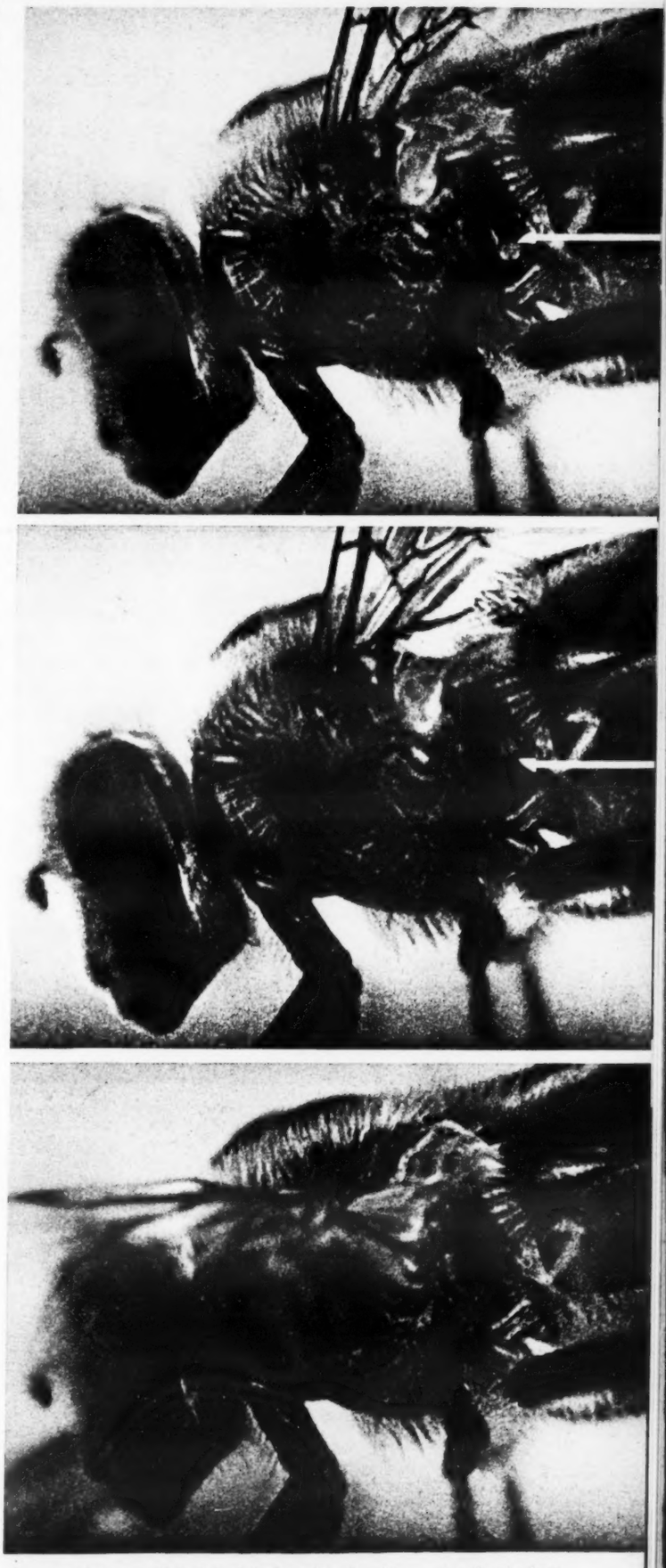
Thus the Sperry Company, in conjunction with scientists of the American Museum of Natural History in New York, initiated a series of experiments on the anatomy and flight of flies. They had an animated enlarged scale model built, which showed clearly the arrangement and shape of the halteres ; this model is at present on exhibition at the Museum. Moreover, the scientists enlisted the aid of Henry M. Lester, a veteran high-speed photographic expert, to attempt to catch flies in flight. Since the wings of a fly beat about 300 times a second, useful results could not be obtained at a photographic speed of less than 3,000 frames per second.

Aside from yielding new information on the wing movements, these motion pictures also disclosed that the halteres move opposite to the wings, moving downward when the wings rise and upward when the wings go down. Serving a balancing purpose in the fly's flight, the halteres work on a purely mechanical principle, like the rotating gyroscope which Man has designed in order to obtain a corresponding result. Thus, once again it is shown that Nature, with organs moving to and fro, atteins the same as engineering does with rotating parts ; but Nature simultaneously sustains and maintains these organs and, furthermore, uses them to register impressions.

The fly's halteres are driven by tiny muscles ; there is no doubt that either the halteres or these muscles are equipped with a series of nerves that register all the forces acting on the tiny rod-like weights. Meanwhile, any small change in flight direction during the short beat of the halteres gives rise to forces which are continuously being detected by the fly's nervous system ; differentiating between linear and angular movements, the latter is able to execute, via the wing control system, the necessary " control compensations. "

What conclusions the Sperry Company will drawn from this excursion of engineering into nature study, cannot yet be discerned. Will this firm, which, with its automatic control equipment, has already provided the aeroplane with a highly-developed nervous system, replace the rotating gyroscope with oscillating elements ? One thought does indeed come to mind : in electrical engineering, particularly in high-frequency technique, everything is based on oscillations ; and Man's inventions during recent years in this particular domain are among the most outstanding of all times. In mechanics, on the other hand, the oscillation is still a principle to be regarded with fear and horror, and whose utility is so far only Wagnerian music. Wagnerian music ? Music !

T.



Three still photos from H. M. Lester's high-speed motion picture : when the wing beats downward, the haltere (see arrow) moves upward and disappears beneath a protective scale. This process is repeated 300 times a second.

The Springbok Grows Wings

"... *South African Airways may inaugurate an air service to the U. S. A. in the near future. S. A. A. is now flying four weekly return flights between Johannesburg and London. S. A. A. is preparing a service along the East Coast of Africa* ..." News of this kind crops up once in a while, and few of us are surprised. South Africa is an air-minded country today and very much "on the map."

The men behind S.A.A. (left to right): *Marshall Clarke*, General Manager of the South African Railways and Harbour Administration of the Department of Transport, which controls the airline company; *F. C. Sturrock*, Minister of Transport; and *G. Leverton*, Manager of S.A.A. The photograph was taken at Kempton Park, Jo'burg, where the Union's great international air terminal is taking shape.

Off to a slow start.

This fact seems to be taken for granted, for few countries provide greater natural encouragement to air transportation than the Union of South Africa, with its bright skies, rare fogs and long distances. Yet, civil aviation in South Africa was limited in scope and public interest for many years. The average citizen seldom thought in terms of air travel: at most, he paid a few shillings for an occasional joy-flip. Although the air services operated to South Africa by Imperial Airways for many years before World War II captured the public imagination, they were something remote from the thoughts of the average man. The air was a realm apart, something abstract, to be braved in a spirit of adventure. It required protracted efforts on the part of South Africa's aviation pioneers to educate the country to its present state of airmindedness.

It seems paradoxical, therefore, that air mails were first carried in South Africa as early as December 27th, 1911, when a South African pilot, E. F. Driver, loaded a mailbag into his Blériot monoplane and flew from Kenilworth to Muizenberg in the Cape Peninsula, a distance of about sixteen miles. It should be explained that the flight was something in the nature of a stunt by the African Aviation Syndicate to advertise commercial flying and a second flight was made on January 4th, 1912. The syndicate, which also possessed a Farman biplane, followed these flights with a series of exhibitions in several of the principal towns of the Union, but failed in 1913 owing to lack of support.

An airliner of the Armstrong-Whitworth *Atalanta* class of Imperial Airways. In 1932, these aircraft were the most modern yet seen in South Africa.

Commercial aviation then lapsed for nearly a decade, due largely, it is true, to World War I. On their return to the Union, some of the 3,000 South Africans who had served in the British flying services obtained various types of small military aircraft for the purpose of carrying out taxi and pleasure riding work, but it was not until 1920 that the next *commercial* enterprise made its appearance. The Company then registered was known as *South African Aerial Transports, Ltd.*, and headed by Major A. M. Miller, D. S. O. However, lack of interest on the part of both the Government and the people of South Africa resulted in this company following in the footsteps of its predecessor shortly after.

The historic flight made about this time from the United Kingdom to the Union by Sir Pierre van Ryneveld and Sir Quentin Brand, two South African airmen who had served with distinction in the Royal Air Force during World War I, aided by the efforts of a small coterie of civil aviation protagonists led by Major Miller, eventually awakened South Africa from its apathy to such good effect that, in 1923, the "Aviation Act" was passed by Parliament. Under this Act a Civil Air Board was appointed to advise the Government on matters relating to civil aviation. As a result of the recommendations of this Board, an experimental air mail service was inaugurated by the South African Air Force between Cape Town and Durban on March 2nd, 1925. The regularity and efficiency with which it was found possible to operate the service throughout its period of fifteen weeks and the quantity of traffic offering demonstrated the feasibility and demand for a regular commercial air service.

Air Mail services begin.

However, with the withdrawal by the South African Air Force of its aircraft and personnel, the Union was once again without any form of air mail service until August 26th, 1929, when a company, *Union Airways,* was formed at Port Elizabeth by Major Miller to operate an air mail service between Cape Town and certain of the major centres of the Union. Since the primary object of the venture was the provision of a more rapid distribution of mail from and to

overseas countries, the schedules were arranged to connect with the incoming and outgoing mailboats, and the Government agreed to subsidise the Company. With a fleet of five D. H. *Gipsy Moth* light aeroplanes, a main mail service between Port Elizabeth and Cape Town was inaugurated with branches from Port Elizabeth to Durban via East London, and to Johannesburg via Bloemfontein. Passengers were carried over certain sections of the routes only in emergencies.

Despite severe handicaps, such as a complete lack of meteorological services and direction-finding facilities, the services were operated to a 100 per cent. standard of efficiency and regularity during the first four months.

With the stabilisation of the services and their general recognition as a rapid means of transport, there arose a widespread demand for passenger accommodation. To cater for this potential traffic, the company purchased a Fokker *Super Universal* six-passenger aircraft and placed it in service, early in 1930, on the Port Elizabeth—Cape Town route. It was regularly used until December 31st, 1931, when it crashed during an electric storm. With the aid of outside support, the Company then enlarged its fleet by three Junkers *F 13's* and two Junkers *W 34's,* in addition to two de Havilland *Puss Moths.*

During 1932, Union Airways decided to introduce a service between Durban and the Rand, to close down the Port Elizabeth—Rand service, and to move its headquarters to the new focal point of activity, Durban. Meanwhile, *South West African Airways* had come into being and had commenced operating a series of local services from Windhoek.

At the beginning of the same year, on January 20th, South Africa's first air link with Europe was forged with the inauguration of Imperial Airways' weekly service between London and Cape Town. Initially, this service, which followed a route down Africa including Cairo, Khartoum, Nairobi, Salisbury, Pietersburg and the Rand (Johannesburg), was operated with Handley Page *Hercules* three-engined aircraft, but these were later replaced with four-engined seventeen-seater Armstrong Whitworth *Atalantas,* which were by far the most modern airliners to be seen in South Africa up to that time.

The three-engined Junkers *Ju 52* transports, of which S.A.A. bought eleven, were put into service in 1934. By their large size and higher speed they changed the whole picture of the South African air services. They were used for transport purposes in World War II.

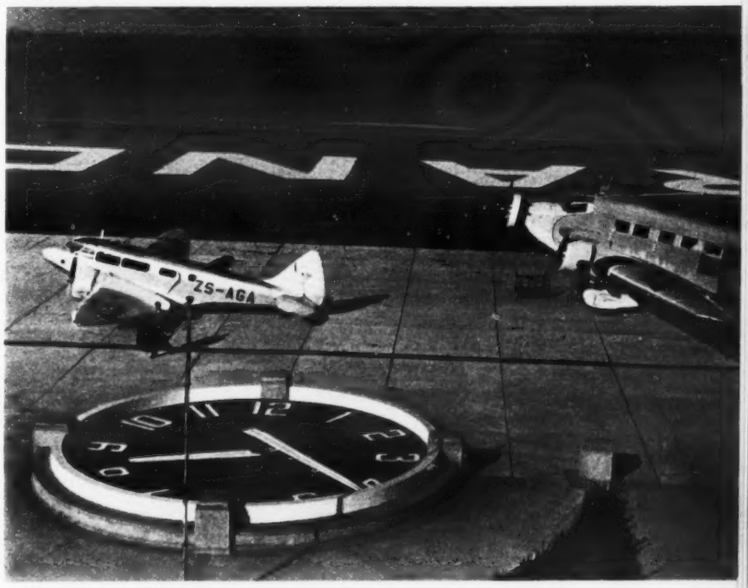
One of S.A.A's. early Junkers *Ju 52's* flying alongside Devil's Peak, Cape Town. A Junkers *Ju 52* and an Airspeed *Envoy* at the Rand Airport, Germiston, Johannesburg, in 1936.

South African Airways takes over.

In 1931, the Union Government began to realise the necessity of maintaining and expanding its internal services. Union Airways was labouring under financial difficulties, and the Government, therefore, decided to operate its own air services. A law, "Act 21" of that year, was therefore passed in Parliament, under the terms of which the South African Railway Administration was given powers to operate its own aircraft for the transport of passengers and goods.

As an initial step it acquired the assets and liabilities of Union Airways, including aircraft and personnel, and on February 1st, 1934, *South African Airways* commenced operations under the direction of the South African Railways and Harbours Administration. In pursuance of the policy of having all scheduled services State-owned, the Government also took over South West African Airways from February 1st, 1935.

After a few months' operations in 1934, the *F 13* and *W 34* three- and four-seater aircraft taken over from Union Airways were replaced by larger and more modern types. Towards the end of October, 1934, three Junkers *Ju 52* fourteen-passenger airliners, on order to Union Airways at the time of the change-over, arrived in South Africa. The new airliners, which had a cruising speed of approximately 150 miles per hour, changed the whole aspect of South Africa's air services. Fitted with wireless equipment for normal communication as well as for direction-finding, the aircraft permitted a far greater degree of safety and efficiency, particularly as direction-



The first Junkers *Ju 86* ten-passenger airliner, a faster successor to the *Ju 52*, arrived in South Africa in June, 1937. Upon the outbreak of war, the entire fleet of 18 *Ju 86*'s was converted for bombing duties and transferred to the South African Air Force.

finding facilities were by now available at Cape Town, Durban and Johannesburg. Expansion was accelerated as a sequel to State control, further *Ju 52*'s were purchased and new services started. South African Airways became a regular client of the German Junkers concern and followed up its *Ju 52* orders with contracts for the faster, ten-passenger Junkers *Ju 86* twin-engined type, the first of which arrived in the Union in June, 1937.

With Johannesburg now assuming the position as the terminal point of all the major services, South African Airways moved their headquarters from Durban to the Rand Airport (Germiston) on July 1st, 1935, which soon became the busiest aviation centre in the Union.

During the years 1936 and 1937, attention was devoted to the provision of more adequate aids to navigation, and by the end of the latter year twelve direction-finding stations had been erected throughout the Union. Additionally, blind-landing equipment was installed at Cape Town airport, where low cloud and rain made approach conditions difficult during the winter months. A marked advance was also effected in the standard of meteorological facilities.

A Lockheed L-18 *Lodestar*, used on S.A.A.'s. domestic services, at Rand Airport, Germiston.

On June 29th, 1937, the Government of the United Kingdom, in collaboration with those of the various Dominions, introduced the non-surcharge air mail scheme, under which mails were carried by Imperial Airways' flying-boats down the east cost of Southern Africa to Durban. With the inauguration of this scheme, Imperial Airways ceased to operate their landplane service between Kisumu and the Rand, and from July, 1937, onwards, this northern route linking the Union with Tanganyika, Kenya and Uganda was operated on a reciprocal basis by South African Airways and Rhodesia & Nyasaland Airways.

Studies of a project for a circular route linking the Union with Portuguese Angola and the Belgian Congo and connecting with the Uganda service at Kisumu began in 1937. As a preliminary move in this direction, a survey flight had inspected the tentative route in August of that year. The route covered by this flight embraced Maun (Bechuanaland), Windhoek (South West Africa), Mosamedes and Luanda (Angola), Brazzaville (French Equatorial Africa), Coquilhatville (Belgian Congo) and Nairobi. The first section of this service—that from the Rand to Luanda—was inaugurated on May 1st, 1939, but before negotiations could be completed for the extension through the Belgian Congo, war broke out and the proposition automatically lapsed.

War breaks out.

With the outbreak of war in September, 1939, the bright prospects of expansion and all the pioneering work which had been done to bring the Airways to a high standard of proficiency were largely nullified, for South Africa suspended all civil flying on May 24th, 1940, and at the same time transferred all aircraft and personnel to the South African Air Force to assist in the Union's war effort. South Africa was, in fact, the only Dominion in which civil flying ceased entirely ; all commercial air lines, taxi services and training schools and clubs were absorbed in the country's defence machine.

South African Airways' fleet of aircraft at that time stood at twenty-nine multi-engined airliners, of which eleven were *Ju 52*'s capable of being used only for transport purposes, while eighteen were *Ju 86*'s, a type originally built as a medium bomber but later modified by the manufacturers to serve as a passenger liner. More modern and faster aircraft were on order, the new types being Junkers *Ju 90* four-engined forty-passenger luxury liners and Lockheed *Lodestar* twin-engined twelve-passenger aircraft. Over and above this, meteorological and wireless services had been brought up to date, aerodrome facilities at most of the main centres were well capable of meeting the needs of modern air-liners, and a system of emergency landing-grounds located every fifty miles along main routes was well advanced.

One of S.A.A.'s. senior pilots, Commander B. Botes. With the rank of Colonel, he commanded an SAAF squadron in the field during the war.

Upon the complete cessation of civil flying, the entire organisation of South African Airways was transferred to the South African Air Force. Without delay, all the *Ju 52*'s were placed on transport work between the Union and Nairobi, the headquarters of the South African Forces operating against the Italians in Abyssinia. This shuttle service carried mails, stores and important personnel to this theatre of war, and, as the campaign advanced, the service was ultimately extended to Addis Ababa. The *Ju 86*'s were converted into medium bombers and some of them posted with their airline crews to Union coastal stations for anti-submarine patrol and for the protection of shipping. It was one of these patrols operating out of Cape Town that spotted the German East African liner " Watussi " some 300 miles south of the Cape, as it endeavoured to make its way back to Germany.

A Douglas *DC-4* photographed over Johannesburg. S.A.A. is planning to buy even larger aircraft.

Upon a signal being sent back by wireless to headquarters and the arrival of a relief aircraft, the captain of the "Watussi" ordered the crew to scuttle the ship. Thus, Germany's first reverse in South African waters is to be attributed to South African Airways. Other *Ju 86*'s operated from Dar-es-Salaam and Mombassa, guarding shipping convoys plying up and down the East African coast to Kenya and North Africa. The remaining converted bombers were posted *en bloc* to a medium bomber squadron, which proceeded to Kenya in May, 1940.

Hm! — S.A.A. is keeping abreast of the times: an air hostess serving aboard one of the *DC-4*'s flying from Johannesburg to London.

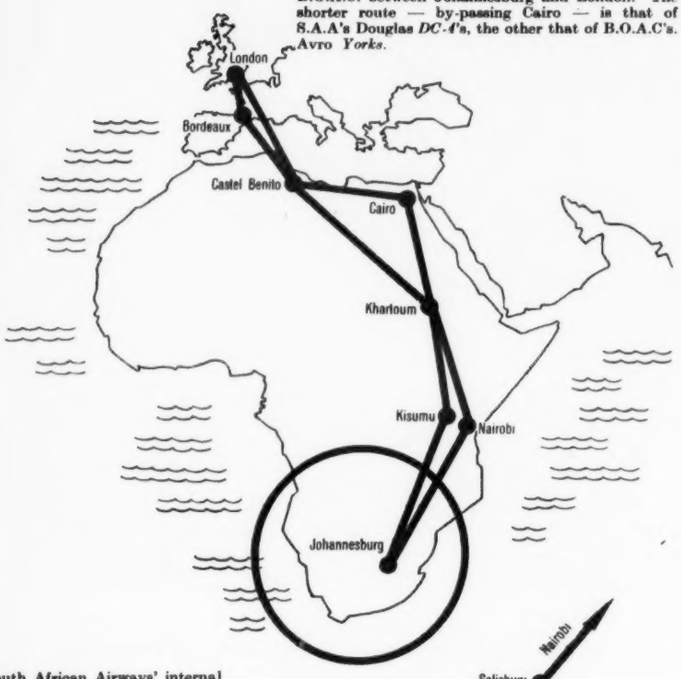
During 1941, considerable South African forces were transferred to the North African theatre of war. This created a demand for air communications between the Union and Cairo, and a shuttle service was therefore introduced. The Lockheed *Lodestars* that had arrived in the meantime proved eminently suited to this work, and all available aircraft of this type were immediately posted to the Transport Wing. Flown and maintained largely by Airways' personnel, the *Lodestars* were responsible for most of the pioneering work on the route, over which they operated for a considerable time until sufficient *Dakotas* became available.

Post-war revival of S.A.A.

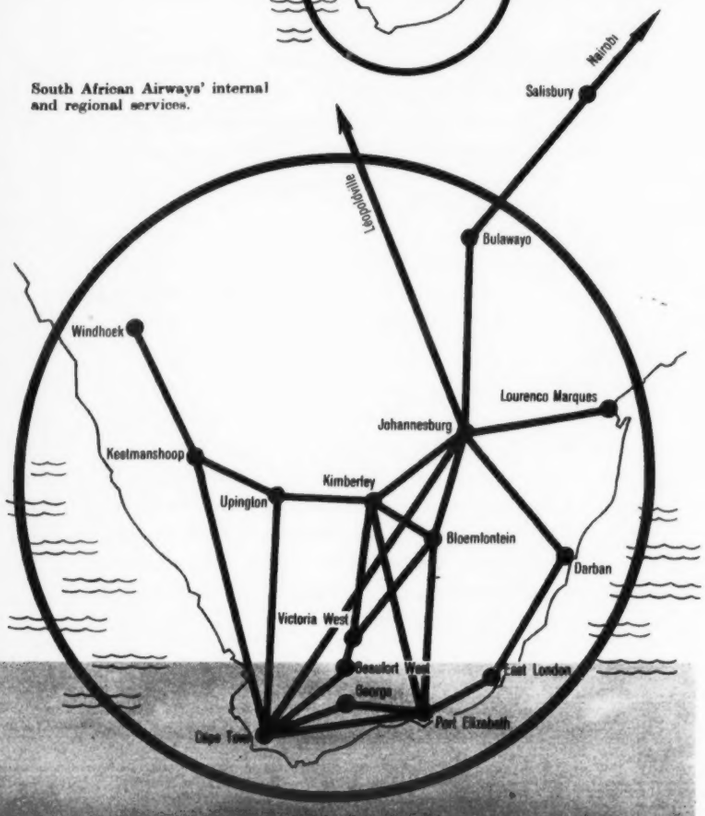
During 1944—the war in Europe was progressing favourably for the Allies—the heads of South African Airways began to elaborate their post-war plans. They were helped by the Government, which authorised the construction of three major airports, namely, one on the Reef (Johannesburg-Pretoria area) and one each at Cape Town and Durban. An initial sum of £3,000,000 was made available for this work. At the end of 1944, investigations were started in connection with the siting of the airports on the Reef and at Cape Town, whilst preliminary work was in hand at Durban. In order to obtain the best possible advice with regard to the construction and equipment of these airports, a number of officers of the Railways and Harbours Administration were sent to the U.S.A. to report on the progress made in airport design and operation by the Americans.

S.A.A. possesses a small fleet of Avro *Yorks* for its longer services. Until recently, they operated on the "Springbok" route to London. This one belongs to B.O.A.C. and was photographed at Palmietfontein temporary international airport.

S.A.A's. "Springbok" service operated in pool with B.O.A.C. between Johannesburg and London. The shorter route — by-passing Cairo — is that of S.A.A's Douglas *DC-4's*, the other that of B.O.A.C's. Avro *Yorks*.



South African Airways' internal and regional services.



For its shorter services S.A.A. has ordered several de Haviland *Dove* feeder aircraft.

At the same time, the Administration opened negotiations with the South African Defence Department for the return to S.A.A. of some of the Lockheed *Lodestars*. Six were released in November, 1944, another six early in 1945. By May, 1945, South African Airways was again operating 26 services weekly. The company has since expanded its operations continuously (there were about 320 services weekly last August), assisted notably by the Post Office Department's decision to re-introduce the carriage of first-class mail without surcharge. In the field of international operations, S.A.A. inaugurated the *Springbok* service between Palmietfontein temporary international airport (Johannesburg) and London on November 10th, 1945, on a pooling basis with British Overseas Airways Corporation.

The extent to which S.A.A's operations expanded between 1935, the company's first complete year of activity; 1938, when daily services to all major centres in South Africa were in operation; and 1946, the first post-war year, is demonstrated in the following comparative statistics:

	1935	1938	1946
Number of aircraft (multi-engined)	4	26	29
Number of pilots	11	31	81
Total staff	101	378	1,228
Aircraft miles	522,257	—	56,000,000
Passengers carried	8,938	34,162	69,065
Weight carried (lbs.)	58,883	112,108	71,817
Mail carried (lbs.)	41,456	2,893,531	1,840,508
Excess luggage (lbs.)	276,711	1,253,356	2,897,641

Owing to the fact that South African Airways is State-owned and financed, little is known concerning its financial status. It seems however, that it, too, is feeling the draught of increased operating costs and higher cost of equipment. For the fiscal year to the end of March, 1947, S.A.A. announced revenues totalling £1,789,993, expenditure amounting to £1,597,361, and a net profit of £192,632. But by the end of July, 1947, the situation had changed considerably : S.A.A. had to report a deficit of £40,996 for that month, and South African finance circles forecast a total deficit of nearly £500,000 by the end of the year. S.A.A. is expected to overcome its difficulties not by fare increases, but by bringing the airways to the people through gradual fare cuts, in other words, by multiplying its present traffic volume.

For this purpose, South African Airways has now embarked on a re-equipment programme which will give it a fleet of 20 Lockheed *Lodestar*, 8 Vickers *Viking*, 2 Douglas *DC-3* and 2 de Havilland *Dove* twin-engined transports, as well as 7 Douglas *DC-4* and 3 Avro *York* four-engined airliners by the end of 1947. Officers of S.A.A. are in the U.S.A. at present to negotiate for the purchase of additional modern twin- and four-engined aircraft for its expanding operations.

This equipment is indispensible if the South African Airways are to realise their projects—new and faster services to the East, West and North of the Dark Continent, to Europe and America. The "Springbok" has grown indeed, and the wings are growing.

Calculating the Longitudinal Stability and Control of Helicopters

By Walter Just, D. Sc. [1]

It is a known fact that helicopters, particularly whilst hovering or flying at low speeds, feature control and stability characteristics that contrast with those of conventional fixed-wing aeroplanes. *Arthur M. Young*, Chief Development Engineer of the Bell Aircraft Corporation's Helicopter Division, in his article summing up the results of interesting experiments he executed with flying models, [2] provided a good epitome of the types of motion and the stability qualities obtainable with helicopters. To be able to survey these control and stability problems in a comprehensive manner, however, and decide on the constructional measures likely to yield optima flying characteristics, it is necessary to place these considerations on a *mathematical* basis. It is not intended here to execute a complicated stability calculation with a large number of degrees of freedom, but to confine the account to the *most important* influences; suitably described, these are relatively easy to define mathematically. In conclusion, very simple formulæ are obtained for the stability and control values; from these the *constructionally-influential values* can easily be read off, thus giving the means of influencing the stability qualities within certain limits.

The stability of an aircraft is generally understood to be its capacity to recover *automatically* (i.e. without control intervention by the pilot) from small divertions (or disturbances), such as may be caused by gusts, for example, and resume its original flight attitude. The recovery can involve either *damped oscillations* or an *aperiodically-damped motion*.

[1] Author of "Performance Calculation for Helicopters"; "INTERAVIA, Review of World Aviation" Vol. II, No. 3, P. 34-41 and No. 4, P. 38-39.

[2] "The Helicopter and Stability"; "INTERAVIA, Review of World Aviation" Vol. II, No. 6, P. 41-42 and No. 7, P. 27-32.

Symbols

HELICOPTER AND ROTOR

COORDINATES:

x_o, y_o, z_o = System of coordinates of the helicopter
x, y, z = System of coordinates of the rotor
t = Time (sec)

DIMENSIONS:

D = Rotor diameter (m)
R = Rotor radius (m)
r = Radius at given point (m)
x = r/R (dimensionless)
F = $D^2\ \pi/4$ = Rotor disc area (m^2)
t = $t_o\ (1 + px)$ = Blade chord at given point (m)
$t_{0.7}$ = Chord at $x = 0.7$ (m)
$\sigma_{0.7}$ = Disc density at $x = 0.7$ (dimensionless)

$$\sigma_{0.7} = \frac{z \cdot t_{0.7}}{R \cdot \pi} \cdot \frac{(R)}{(R)} \searrow \frac{z \cdot \textit{blade area}}{\textit{rotor disc area}}$$

a = Flapping-hinge distance (m)
h = Neutral point to flapping-hinge plane (m)
h_s = Neutral point to centre of gravity (m)
z = Number of blades

FORCES:

G = Gross weight (kg)
m = Helicopter mass ($kg \cdot sec^2 \cdot m^{-1}$)

$$m = \frac{G}{g}\ (g = 9.81\ m/sec^2)$$

P_{res} = Rotor resultant (kg) (resultant air force on the rotor)
A = Lift (kg) (perpendicular to direction of flight)
$\pm W$ = Drag (kg) (against and in direction of flight)
$+W_{Ro}$ = Rotor drag (kg) (autogyro)
$-W_{Ro}$ = Rotor thrust (kg) (helicopter)
$+W_s$ = Parasite drag of remaining helicopter
$+P_x$ = Component of rotor resultant in negative x-axis direction (kg)
$+P_z$ = Component of rotor resultant in negative z-axis direction (kg)
$+P_{ZA}$ = Force of a rotor blade in negative z-axis direction (kg)
Z = Centrifugal force of a rotor blade (kg)

MOMENTS AND POWERS:

M = Torque moment, general (mkg)
$+M_{Ro}$ = Tail-heavy moment of rotor about the C.G. (mkg)
$+M_y$ = Tail-heavy moment of rotor about the (transverse) y-axis (mkg)
M_{GRo} = *Weight* moment of a rotor blade referred to rotor axis (mkg)
J_y = Inertia moment of helicopter about the lateral (y_o) axis ($mkg\ sec^2$)

SPEEDS:

v = Flying speed (m sec^{-1})
w = Rate of ascent (m sec^{-1})
w_s = Rate of descent (m sec^{-1})
U = Rotor tip speed (m sec^{-1})
v_x, v_z = Flying speed components in x- and y-axis directions (m sec^{-1})
n_{Ro} = Number of revolutions of rotor (r.p.m. or sec^{-1})
n_{Mo} = Number of revolutions of engine (r.p.m.)
ω = Angular speed of rotor (m sec^{-1})
ω_y = Angular speed of helicopter when turning about the lateral (y_o) axis (m sec^{-1})
q = Dynamic pressure (kg/m^2)

$$q = \frac{v^2\ \gamma}{2g} = \frac{v^2\ \rho}{2}$$

ρ = Air density ($kg\ sec^2\ m^{-4}$)

$$\rho = \frac{\gamma}{g}$$

γ = Specific weight of the air ($kg\ m^{-3}$) (varying according to altitude)

ANGLES:

α_x = Angle of incidence of rotor flapping-hinge plane to direction of flight (radians or degrees)
α = Angle between rotor flapping-hinge plane and plane perpendicular to control axis (radians or degrees)
ϑ = $\vartheta_o + \vartheta_1\ x + \vartheta_2/r$ = Rotor blade angle of setting at given point (radians or degrees)
$\vartheta_{0.7}$ = Angle of blade setting at $x = 0.7$ (degrees)
$\vartheta^*_{0.7}$ = Angle of blade setting at $x = 0.7$ due to blade control (degrees) $\vartheta^*_{0.7} = \vartheta_{0.7} + \vartheta_s\ sin\ \psi$
ϑ_s = Control amplitude of cyclic pitch change (radians or degrees)
ψ = Rotation angle $\psi = \omega \cdot t$ ($\psi = 0$ = aft) (degrees)
β = $a_o - a_1\ cos\ \psi - b_1\ sin\ \psi$ = Blade flapping angle (radians)
a_o = Coning angle (radians)
γ = Angle between flight path and horizontal (radians or degrees)
ϵ = Angle between flapping-hinge plane and horizontal (radians or degrees)
η_x = Deflection of rotor control axis in relation to rotor shaft (radians or degrees) $\eta_x = -\vartheta_s$
ν = Angle between rotor resultant and control axis (radians or degrees)
σ = Angle between rotor shaft and line connecting neutral point and C.G. (radians or degrees)
κ = Angle between aircraft longitudinal

axis (x_o) and flapping-hinge plane (radians or degrees)

57.3 = $\frac{180}{\pi}$ = Conversion factor for radians into degrees

COEFFICIENTS (based on rotor disc area):

c_a = Lift coefficient of rotor, based on *flying* speed (v)

$$A = c_a \frac{\rho}{2} v^2 F$$

k_a = Lift coefficient of rotor, based on *tip* speed (U)

$$A = k_a \frac{\rho}{2} U^2 F$$

k_w = Drag coefficient of rotor, based on tip speed (U)

$$W_{Ro} = k_w \frac{\rho}{2} U^2 F$$

OTHER COEFFICIENTS:

$K_{0.7}$ = Blade constant for calculating a_o (radians^{-1})

λ = $\frac{v}{U}$ = Advance ratio (dimensionless)

$c'_{a\infty}$ = Lift gradient of blade section ($c_a = \phi\ (a_{eff})$) (radians^{-1})

ELEVATOR UNIT:

F_H = Area of horizontal stabilisor (m²)

l_H = Distance between elevator C.P. and aircraft C.G. (m)

$-M_H$ = Nose-heavy moment of horizontal stabilisor forces about C.G. (mkg)

c'_{aH} = Lift gradient of horizontal stabilisor (radians^{-1})

a_H = Angle of incidence of horizontal stabilisor

a_{Ho} = Angle of incidence of horizontal stabilisor in undisturbed status

a_w = Angle of downwash on horizontal stabilisor (radians or degrees)

ϕ = Angle of incidence of horizontal control surfaces (incl. trimming) relative to fuselage longitudinal (x_o) axis (degrees)

OSCILLATION VALUES:

T = Period of a complete oscillation

t_H = Half-amplitude period (damped oscillation)

t_D = Double-amplitude period (oscillation with increment)

Λ = Root of the "characteristic equation"

δ' = Damping

ν' = Frequency

a, b, c = Coefficients of the "characteristic equation"

A helicopter has relatively many possibilities of motion, or degrees of freedom. If we imagine a system of coordinate axes (x_o, y_o, z_o) *fixed in the helicopter* and taking their origin in the centre of gravity, with the x_o-axis directed forwards, the y_o-axis to the right and the z_o-axis downwards (cf. Fig. 1), then we shall be concerned with the following degrees of freedom for every general type of motion:

a) three possibilities of translation in the direction of the three axes (x_o, y_o, z_o);

b) three possibilities of rotation about these three axes (ω_x, ω_y, ω_z);

c) the rotor's degrees of freedom:
rotation on its power shaft (at ω),
flapping movement of the blades (upwards and downwards) (β),
rocking movement of the blades (fore and aft).

By adding the *torque oscillations* and *bending oscillations* of the rotor blades, we have before us a relatively complicated oscillatory picture.

It is, of course, possible to study all these degrees of liberty simultaneously, but it would be a tedious task. For this reason we shall deal here with the *longitudinal* stability alone, assuming the following (simplified) degrees of freedom for the helicopter:

(a, 1) motion in x_o-direction at v_x (m/sec);

(a, 3) motion in z_o-direction at v_z (m/sec);

(b, 2) rotation about the y_o-axis at ω_{ij} (sec^{-1}).

Consideration of the longitudinal motion alone is applicable to helicopters equipped with *contra-rotating* rotors, since there is no relation between this motion and the lateral motion. *Single-rotor* types, in contrast, do indeed feature a certain relation between the longitudinal and lateral motions. Meanwhile, we can apply the results of a calculation executed with simplified assumptions (without relation) to a single-rotor helicopter or autogyro, if we assume that the *pilot* constantly balances the forces which incite lateral motion.

As already stated, the *rotor's* degrees of freedom must be considered in addition to those of the entire helicopter. Let us first examine a conventional rotor with flapping and rocking hinges. Accurate investigations have shown that, without committing any great error, one may assume the rotor blades to be *rigid*, and disregard the reciprocal reactions of the rotor blades and helicopter, i.e., that the movements of the blades and the forces acting on the rotor adapt themselves instantaneously to the condition of flight. (Incidentally, one should compare, in contrast, the Bell-type helicopter.) We may also disregard the minor influences due to gyro forces, tilt damping, airflow divertion, etc.

These three degrees of freedom and their related motions v_x, v_z and ω_{ij} may be expressed more easily with the following values which are dependent on them (in this connection, cf. Fig. 1):

Flight path speed (v);

Rotor angle of attack (a_s)
i.e. angle between flapping-hinge plane and direction of flight;

Angle between flight path and horizontal (γ).

For calculating the longitudinal motion, the relevant equations must be established. In all, there are three equations: two for the equilibrium of forces in the direction of flight and perpendicular to it; a third for the equilibrium of moments about the y_o-axis.

In flight direction:

$$(1) \qquad \mp W_{Ro} \pm m \frac{dv}{dt} + W_s \pm G \sin\gamma = 0$$

which signifies that the rotor thrust (or drag), mass force, drag of the remaining helicopter (without rotor) and weight components (against or in flight direction) are in equilibrium.

Perpendicular to flight direction:

$$(2) \qquad +A - m.v.\frac{d\gamma}{dt} - G\cos\gamma = 0$$

which signifies that the rotor lift, centrifugal force (to which the helicopter mass is subjected during flight-path angle [$\Delta\gamma$] changes) and weight components perpendicular to flight direction are in equilibrium.

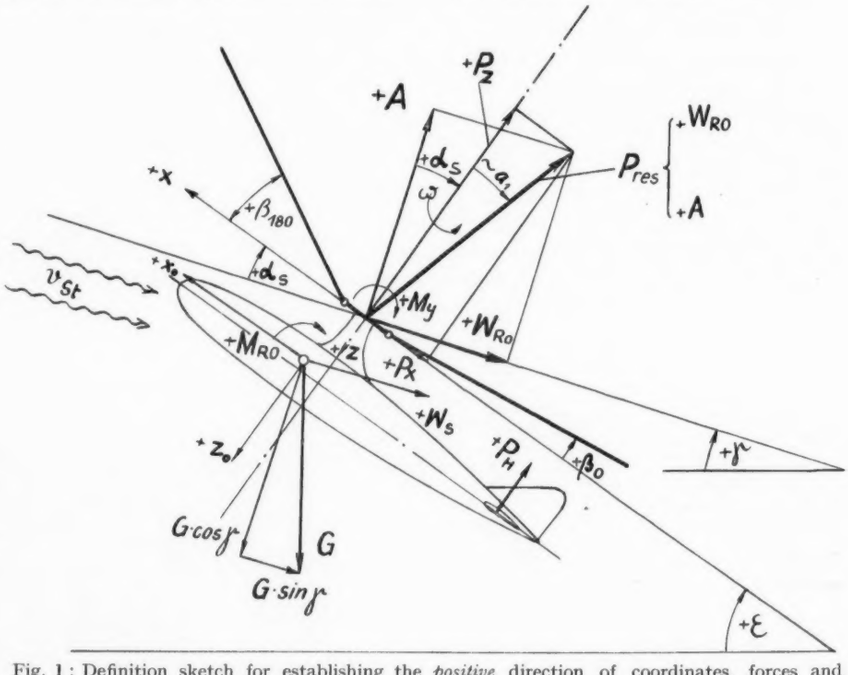


Fig. 1: Definition sketch for establishing the *positive* direction of coordinates, forces and angles. (In actual helicopter forward flight, a_s is *negative* and $-W_{Ro}$ inclined forwards)

x_o = Helicopter longitudinal axis
z_o = Helicopter vertical axis
x = Rotor flapping-hinge plane
z = Rotor axis of rotation
v_{st} = Air stream direction

Equilibrium of moments about the transverse axis:

$$(3) \qquad -J_y \frac{d^2\epsilon}{dt^2} + M_{Ro} - M_H = 0$$

which signifies that the mass moment (masses distributed in the helicopter's longitudinal section about the transverse axis), rotor moment about the C.G. and horizontal stabilisor moment about the C.G. are in equilibrium.

Herein:

lift of rotor $A = k_a \frac{\rho}{2} U^2 F$

drag of rotor (or thrust), $W_{Ro} = k_w \frac{\rho}{2} U^2 F$

parasite drag of other helicopter parts, $W_s = c_{ws} \frac{\rho}{2} v^2 F$

In order to calculate the separate values, we must first consider the forces attacking the rotor, which brings us to the subject of rotor aerodynamics.

ROTOR AERODYNAMICS
(WITHOUT ROTOR CONTROL)

Let us examine a conventional rotor with flapping and rocking hinges. In *hovering condition*—provided we *disregard*, temporarily, the cyclic pitch control—the resultant thrust of the rotor will be in the direction of the axis of rotation, this for reasons of symmetry. In turning about this axis, the blades describe a cone. In the paragraphs which follow, β refers to the angle, at any time, between a blade and the flapping-hinge plane (cf. Fig. 1). In hovering condition, this angle is of constant value ($\beta \backsim a_o$).

In *forward flight*, however, dissymmetries arise, due to the fact that the rotor does not receive the airflow in the direction of its shaft (like a normal airscrew), but approximately in its *plane of rotation*. The blades, therefore, whilst turning, are subjected to varying airflow conditions. The tips, for instance, which have a peripheral speed of U, attack the air at a speed of $(U + v)$ when, for example, $\psi = 90$ deg., and $(U - v)$ when $\psi = 270$ deg. (cf. Fig. 2). Thus different air forces [3] arise in the separate sectors and, consequently, a variable flapping angle β, which may be expressed in the form of a Fourier series:

$$(4) \qquad \beta = a_o - a_1 \cos\psi - b_1 \sin\psi - \ldots\ldots$$

The cosinus term refers to a tilting of the blade cone towards the rear, as will be shown later; the sinus term, a tilting in lateral direction. The terms a_o, a_1 and b_1 are known as *flapping coefficients*. For our purpose (longitudinal stability), only the first two terms, a_o and a_1, are of significance.

[3] as well as vertical *blade* inertia forces, caused by the changes in flapping angle $d\beta/dt$ and in centrifugal force direction, which exercise a lagging influence. - Ed.

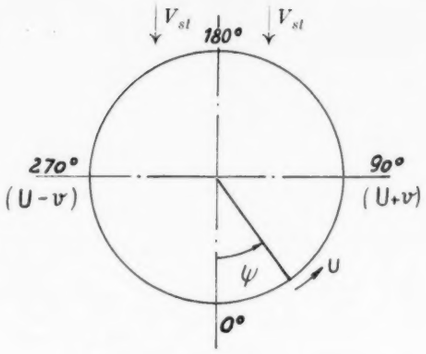


Fig. 2: Definition of the rotation angle (ψ). v_{st} signifies the direction of flow; $\psi = 0$ is therefore aft.

a_o is the so-called *coning angle*. At constant rotor r.p.m., this varies only very little with the flying speed. The flapping coefficient a_1 is approximately *linearly* dependent on the speed of the helicopter, thus on the advance ratio λ. For working out these values, we may use the following formulae which, certain unimportant terms disregarded, have been obtained by means of exact calculation:

$$(5) \qquad a_o = K_{0.7}\left(\frac{k_a}{8.75 \cdot \sigma_{0.7}} + \vartheta_{0.7} \cdot 0.0215\right)$$

$$(6) \qquad a_1 = \lambda \left(\frac{k_a}{1.14\ \sigma_{0.7}} + \vartheta_{0.7} \cdot 1.4\right)$$

(Both values in radians)

Herein, the blade constant ($K_{0.7}$) is equal to:

$$K_{0.7} = \frac{\frac{\rho}{2} \cdot R^4\, c'_{a\backsim} \cdot t_{0.7}}{J_A} \text{ (radians}^{-1}\text{)}$$

whereby J_A signifies the inertia moment of the blade, referred to the flapping axis A. The blade constant $K_{0.7}$ is about equal to $5 \cdot \frac{\rho}{\rho_o}$. The disc density at 0.7 R ($\sigma_{0.7}$) equals 4 to 6 per cent. and the angle of blade setting at the same spot ($\vartheta_{0.7}$), approximately 12 degrees or 0.209 radians.

According to equation (4), the blade features the position $\beta = a_o - a_1$ when $\psi = 0$ deg., but in front, contrariwise, when $\psi = 180$ deg., its position is $\beta = a_o + a_1$. This signifies that the cone which the blades describe is tilted rearwards through the angle a_1. It is clearly evident, as exact calculation will prove, that the resultant rotor force lies approximately in the axis of the cone. Thus the flapping coefficient a_1 gives us the angle at which the rotor resultant P_{res} inclines rearwards in relation to the rotor axis of rotation (cf. Fig. 1). By placing a system of coordinates (x, y, z) in the flapping-hinge plane, as is shown in Fig. 1, we can determine all the rearward-inclined force components located in this plane, in the following manner:

$$(7) \qquad P_x = P_{res} \cdot \sin a_1 \backsim P_{res} \cdot a_1$$

Substitution of radians for the sinus, meanwhile, only results in a very small degree of error. For the rotor *drag*, in this case, we obtain (according to Fig. 1):

$$W_{Ro} = P_{res} \cdot \sin(a_s + a_1) \backsim P_{res}(a_s + a_1)$$

Since the rotor resultant (P_{res}) can very easily be replaced by the lift, we have:

$$(8) \qquad W_{R)} = A(a_s + a_1)$$

or dimensionless, with $A = k_a (\rho/2) U^2 F$ and $W_{Ro} = k_w (\rho/2) U^2 F$,

$$(9) \qquad k_w = k_a (a_s + a_1)$$

In Fig. 1, the rotor resultant is shown to attack at the point of intersection between the rotor axis of rotation and the flapping-hinge plane, thus at the origin of the rotor system (x, y, z); and a moment (M_y) about this point is also given. This resultant ($P_{re.}$) and the moment (M_y) can, of course, also be replaced by an equal force acting in the same direction, though having a different point of attack, which, referred to the origin of the coordinate system, gives the moment M_y. In order to calculate the position of this new resultant, we shall start from Fig. 3. We may assume that the resultant of all forces attacking a rotor blade lies approximately *in the blade*. It is about equal to the blade's centrifugal force, thus:

$$(10) \qquad Z = \int_A^B \omega^2 \cdot r \cdot d\,m = \omega^2 \frac{M_{GR}}{g}$$

whereby: $\frac{M}{g} = \int_A^B r \cdot d\,m$

The force (P_{ZA}) attacking the flapping hinge (A) then works out (cf. Fig. 3) at:

$$(11) \qquad P_{ZA} = Z \sin\beta \backsim Z \cdot \beta \backsim \omega^2 \frac{M_{GR}}{g} \beta$$

The moment (M_{yBl}) of the blade about the y-axis at that point is therefore:

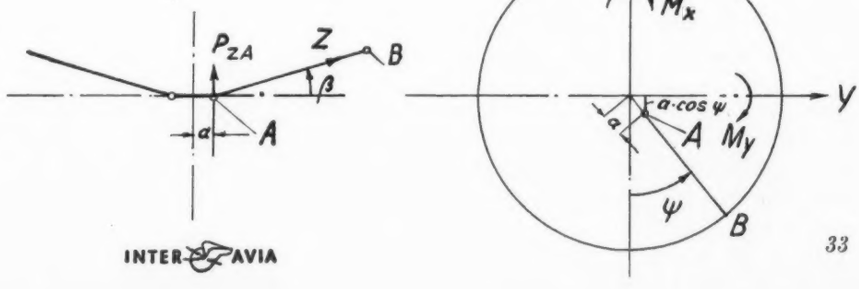


Fig. 3: Forces, angles and distances for calculating the forces attacking a rotor blade (geometrical sum, Z, of all blade forces lying in the blade axis).

(12) $M_{yBl} = -P_{ZA} \cdot a \cdot \cos\psi$

or, with β according to (4):

(13) $M_{yBl} = -\omega^2 \frac{M_{GR}}{g} \cdot a \cdot \cos\psi \cdot$
$\cdot (a_o - a_1 \cos\psi - \ldots)$

If we now form the mean value for the entire rotor with z blades, we obtain:

$$M_y = \frac{z}{2\pi} \int_0^{2\pi} M_{yBl}\, d\psi = \frac{z}{2\pi} \frac{M_{GR}}{g} a \cdot$$
$$\cdot \left(\int_0^{2\pi} a_1 \cos^2\psi\, d\psi - \int_0^{2\pi} a_o \cos\psi\, d\psi \right)$$

The first determined integral becomes $a_1 \cdot \pi$, the second zero, so that:

(14) $M_y = \frac{z}{2} \omega^2 \frac{M_{GR}}{g} a \cdot a_1$

With h referring to the height above the flapping-hinge plane at which the rotor resultant passes through the axis of rotation (cf. Fig. 4), we obtain:

(15) $P_x \cdot h = M_y$

The magnitude of the rotor resultant (P_{res}) works out, with the values from equation (11), at:

(16) $P_{res} = \frac{z}{2\pi} \cdot \int_0^{2\pi} P_{ZA}\, d\psi$

$$= \frac{z}{2\pi} \int_0^{2\pi} \omega^2 \frac{M_{GR}}{g} (a_o - a_1 \cos\psi - b_1 \sin\psi)\, d\psi$$

which, evaluated, is:

(17) $P_{res} = z \cdot \omega^2 \frac{M_{GR}}{g} \cdot a_o$

For P_x, therefore, we obtain from equation (7):

(18) $P_x = z \cdot \omega^2 \frac{M_{GR}}{g} \cdot a_o \cdot a_1$

Accordingly, the height h in Fig. 4, based on equation (15) with M_y as in equation (14), works out at:

(19) $h = \frac{M_y}{P_x} = \frac{\frac{z}{2} \omega^2 \frac{M_{GR}}{g} \cdot a \cdot a_1}{z \cdot \omega^2 \frac{M_{GR}}{g} \cdot a_o \cdot a_1}$

thus, according to the simple formula:

20 $\boxed{h = \frac{a}{2 \cdot a_o}}$

Here, as will be remembered, a denotes the flapping-hinge distance, and a_o the coning angle, which amounts to approximately 0.1 radians or about 6 degrees. Since the coning angle (a_o) scarcely changes with the flying speed (cf. equation 5), the height h also remains neutral in relation to changes in speed, for which reason we shall call this point (N) the "*neutral point*" of the rotor.

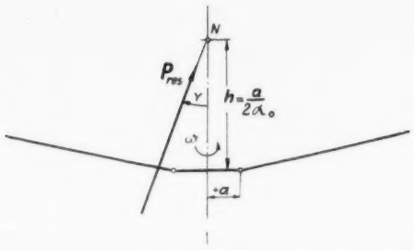


Fig. 4: Definition of the "neutral point." (For the sake of convenience, the angle ν is measured against the control axis which, here, coincides with the rotor axis of rotation.)

The resultant air force attacking the entire rotor can therefore, as has been shown here, be defined with three quantities:

1. *Magnitude* of the force P_{res}, which is approximately equal to the lift
$(A = k_a \frac{\rho}{2} U^2 F)$;
2. *Inclination* of this resultant in relation to the rotor axis of rotation;
3. *Height* of the neutral point above the flapping-hinge plane (h).

ROTOR CONTROL

We have hitherto set the condition that the rotor be subjected to no control action by the pilot. In order to understand better what happens when the rotor is controlled —notably in the case of *blade control*,[4] to which we shall confine ourselves here—we shall again start from the *hovering condition*. As has already been stated, without control action, the rotor resultant P_{res} lies in the axis of rotation.[5] Through the control action (longitudinal control), this resultant is now tilted within a certain angular range fore or aft about the neutral point. The angle of deflection of the rotor control axis in longitudinal section shall be called η_x (Fig. 5), and we shall calculate it in the positive sense of "pushing."[6] As will be shown later, the deflection of the rotor control axis, $+\eta_x$, also causes the rotor resultant to be tilted in the "pushing" sense, i.e., tilted forwards. The tilting of the resultant is achieved by using a special kinematic (swash plate, spider, etc.) to force the blade to assume a cyclic turning motion about its longitudinal axis, of the form:

$$\Delta\vartheta = \vartheta_s \cdot \sin\psi.$$

At $x = 0.7$ and ψ, the blade features the angle of setting:

(21) $\vartheta^*_{0.7} = \vartheta_{0.7} + \vartheta_s \sin\psi$

Exact calculation and measurement has enabled us to establish that, by the supplementary—cyclically variable—angle of blade setting ($\Delta\vartheta = \vartheta_s \sin\psi$), which has the value 0 at $\psi = 0$ deg., $+\vartheta_s$ at $\psi = 90$ deg. and again 0 at $\psi = 180$ deg., the blades are given a flapping motion which results in an increase in *flapping angle* of $\Delta\beta = +\vartheta_s$, not at $\psi = 90$ deg., but at $\psi = 180$ deg.,[7] and accordingly, at $\psi = 0$ deg., a decrease in flapping angle of $-\vartheta_s$, whilst the flapping angle remains unchanged at the lateral points where $\psi = 90$ deg. and $\psi = 270$ deg. This means that, compared to the change in

[4] In addition to the most frequently used blade controls, there also exist rotor control systems which *tilt* or *displace* the rotor head. – Ed.

[5] Hence, in hovering flight, the helicopter C.G. would also have to lie in the axis of rotation. But this is not usually the case. Therefore, a rotor control action is also necessary during the hovering flight. – Ed.

[6] The rotor control axis, which is often only an imaginary axis, must not be confused with the control column. The reader may be apt to imagine that in hovering flight condition, the rotor resultant is in the prolongation of the rotor control axis. If the rotor resultant is inclined forwards (pushing), then the control axis points rearwards. Meanwhile, this corresponds to a forward deflection of the control column. – Ed.

[7] Again caused by the blade mass forces; cf. footnote 3. — Ed.

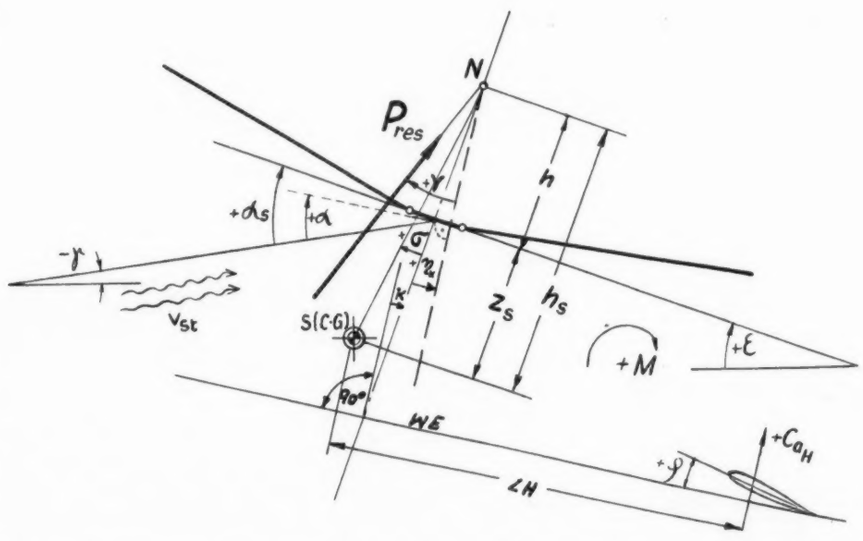


Fig. 5: Distances and angles for establishing the rotor resultant (P_{res}), C.G. position (a) and control angle (η_x), as well as symbols referring to the horizontal stabilisor. *(Definition sketch.)*

angle of setting, $\Delta\,\vartheta$, the flapping angle $\Delta\,\beta$ involves a *phase shift of 90 deg*. The supplementary flapping motion $\Delta\beta$ causes—at positive amplitudes—a rearward tilting of the blade cone through ϑ_s, and consequently an approximately equal tilting of the rotor resultant. If, therefore, we choose $\vartheta_s = -\eta_x$, then the rocking angle of the rotor resultant in hovering flight will also be equal to $-\eta_x$, which signifies that, *in hovering flight, the rotor resultant lies in the rotor control axis.*

(22) $-\eta_{c\ \text{control}} = +\vartheta_{s\ \text{blade}} = -\eta_{x\ \text{resultant}}$

It may be mentioned briefly that, in single-rotor helicopters, the *lateral* control, thus the creation of side motions, and moments about the x_0-axis, are accomplished with a cyclic blade-pitch change of the form $\Delta\,\vartheta = \vartheta_{c1}\,cos\,\psi$.

If the rotor is now additionally subjected to airflow influence—e.g. in forward flight with the speed v—then the resultant again wanders away, leaves the control axis in which it lay at $v = 0$, and assumes the position $\nu = a_1$ in relation to it (Fig. 5). In a helicopter *without* horizontal stabilisor, or in hovering flight—with convenient C.G. position—the control deflection η_c must be chosen so that the rotor resultant passes through the C.G. Under these circumstances, we find $-\eta_x = \sigma$ and $\nu = 0$; on the other hand, we find that when there is a horizontal stabilisor—in *forward flight*—the moment of the rotor resultant, referred to the C.G., is equal to the moment of the horizontal stabilisor.

If, for determining the position of the C.G., we introduce the angle σ (cf. Fig. 5), then we first obtain the rotor moment about the C.G. :

(23) $$M_{Ro} = P_{res}\,h_s\,(\nu - \eta_x - \sigma)$$

whereby ($h_s = z_s + h$) is equal to the distance of the C.G. from the rotor neutral point (N).

For the *horizontal stabilisor moment*, it may be deduced from Fig. 5 that :

(24) $$-M_H = -F_H \cdot l_H \cdot q \cdot c_a'_H\,(\alpha_s - \alpha_w + \phi - \kappa)$$

Above, we used α_s for the angle between the direction of flight and the flapping-hinge plane (cf. Fig. 1). In order to be able to compare the results obtained by measurement with those derived by calculation, it is all the same wise to introduce an angle of incidence, α, measured between v and a plane perpendicular to the *control axis* :

(25) $$\alpha = \alpha_s - \eta_x$$

Consequently, we obtain for the horizontal stabilisor moment :

(26) $$-M_H = -F_H \cdot l_H \cdot q \cdot c'_{aH} \cdot (\alpha - \alpha_w + \phi - \kappa + \eta_x)$$

In uniform flight—the fuselage moment disregarded—the rotor moment must be compensated by the horizontal stabilisor moment :

$$+M_{Ro} - M_H = 0$$

From this relation may be calculated the necessary control deflection. If we make the rotor resultant equal to $P_{res} = c_a \cdot q \cdot F$, then we have, from equations (23) and (26), for the control angle η_x (in degrees) :

(27) $$\eta_x^o = \frac{c_a \frac{h_s}{R}(\nu - \sigma) - \frac{F_H \cdot l_H}{F \cdot R} \cdot c'_{aH} \cdot (\alpha - \alpha_w + \phi - \kappa)}{c_a \cdot \frac{h_s}{R} + \frac{F_H \cdot l_H}{F \cdot R}\,c'_{aH}}$$

(All angles in degrees ; division of numerator and denominator by $F \cdot R$.)

For calculating the control angle according to equation (27), the curves of the lift coefficient (k_a) over the angle of setting incidence (calculated according to equation 25) must be given, as well as the magnitude of the downwash a_x. As the calculation of several examples has revealed, *control instabilities* can occur at certain C.G. positions and horizontal stabilisor trimmings for higher speeds, i.e., for attaining still higher speeds, the control column must not be pushed, as usual, but pulled. By a suitable choice of the C.G. position (σ) and horizontal stabilisor trimming (ϕ), however, these instability conditions can be avoided.

DYNAMIC LONGITUDINAL STABILITY

In forward flight:

For calculating the dynamic longitudinal stability, let us return to the equation system (1, 2, 3). We shall confine ourselves to medium advance ratios ($\lambda = \frac{v}{U}$), about up to $\lambda = 0.3$. In this way we can achieve a considerable degree of simplification. At these advance ratios, the lift of the rotor (A) is only very slightly dependent on the angle of incidence α. In addition to this, we obtain negligible path curvatures. It therefore becomes unnecessary to go into equation (2). At present, we are occupied only with two degrees of freedom, v and α. If we substitute the expressions for M_{Ro} and M_H from equations (23) and (26), into equations (1) and (3), then we obtain, with $W_{Ro} = k_w\,(\rho/2)\,U^2\,F$ and $W = c_{ws}\,(\rho/2)\,v^2\,F$:

(28) $$\mp k_w \frac{\rho}{2} U^2 F \pm m \frac{dv}{dt} + c_{ws} \frac{\rho}{2} v^2 F \pm G \cdot sin\,\gamma = 0$$

(29) $$-J_y \frac{d^2\epsilon}{dt^2} + P_{res} \cdot h_s\,(\nu - \eta_x - \sigma) - F_H l_H q\,c'_{aH} \left(\alpha - \alpha_w + \phi - \kappa + \eta_x + l_H \frac{d\epsilon/dt}{v}\right) = 0$$

The last term ($l_H = \frac{d\epsilon/dt}{v}$) is originated by the turning motion ($d\epsilon/dt$) of the helicopter relative to the ground. As is known, this system is dealt with in accordance with the method of small oscillations ; we therefore introduce :

(30) $$\Delta\,v = v_1 \cdot e^{\Lambda t}$$
$$\Delta\,\alpha = a_1 \cdot e^{\Lambda t}$$

and after some calculation, we obtain, by setting the usual determinants equal to zero, the following *characteristic equation* of the third order :

(31) $$\Lambda^3 + a\,\Lambda^2 + b\,\Lambda + c = 0$$

with the coefficients

$$a = g\frac{k_{wv}}{k_a} + \rho \cdot v\left(\frac{c_{ws} \cdot F}{m} + \frac{F_c \cdot l_H}{2\,J_y}\right)$$

(32) $$b = -\frac{G}{J_y} h_s \cdot \nu_\alpha + \frac{k_{wv} \cdot g}{k_a \cdot J_y} F_c \cdot l_H \frac{\rho}{2} v + \frac{F_c}{J_y} \cdot q\left(1 + \frac{c_{ws} \cdot F \cdot \rho \cdot l_H}{m}\right)$$

$$c = -(G \cdot h_s \cdot \nu_\alpha - F_c \cdot q)\left(\frac{g}{J_y}\frac{k_{wv}}{k_a} + \frac{C_{ws} \cdot F \cdot \rho \cdot v}{m \cdot J_y}\right) + \frac{g}{J_y}\frac{k_{wu}}{k_a}(G \cdot h_s \cdot \nu_v - F_c \cdot \rho \cdot v \cdot \alpha_{Ho})$$

whereby

$$F_c = F_H \cdot l_H \cdot c'_{aH}$$

(33) $$k_{wv} = \frac{\partial k_w}{\partial v} \quad ; \quad k_{wu} = \frac{\partial k_w}{\partial \alpha}$$
$$\nu_v = \frac{\partial \nu}{\partial v} \quad ; \quad \nu_\alpha = \frac{\partial \nu}{\partial \alpha}$$

For the normal case, this equation of the third order (31) gives one real and two complex solutions :

(34) $$\Lambda_1 = \text{real}$$
$$\Lambda_2 = \delta' + i \cdot \nu'$$
$$\Lambda_3 = \delta' - i \cdot \nu'$$

The first root (Λ_1) denotes an aperiodical share of the motion, which usually fades away very quickly, and is not of very great interest in the present connection. The roots Λ_2 and Λ_3 represent oscillations equal to Δv and $\Delta\alpha$, respectively. For these oscillations, one may state :

(35) $$\Delta\,v = D_1 \cdot e^{\delta' t} \cdot sin\,(\nu' t - \Phi_1)$$
(36) $$\Delta\,\alpha = D_2 \cdot e^{\delta' t}\,sin\,(\nu' t - \Phi_2)$$

Here, δ' denotes the damping, ν' the frequency, Φ_1 and Φ_2 the phase shifts, and D_1 and D_2 the integration constants.

From these quantities (δ' and ν', according to equation 34), the oscillation and stability magnitudes can be derived in the usual way. For the period of oscillation (cf. Fig. 6), one obtains :

(37) Period of a complete oscillation :

$$T = \frac{2\,\pi}{\nu'}\,(sec)$$

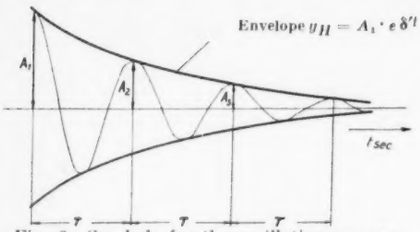


Fig. 6 : Symbols for the oscillation process.

The half-amplitude period, i.e., the time (t_H) after which the envelope $y_H = A_1 \cdot e^{\delta' t}$ (cf. Fig. 6) has decreased to half its value, is :

(38) Half-amplitude period :

$$t_H = \frac{-l_n 2}{\delta'} = -\frac{0.693}{\delta'} \ (sec) ;$$

(δ' = negative)

In the case of incremental oscillations, we must also consider the double-amplitude period (t_D), i.e., the time after which the envelope has increased to twice its value. It amounts to :

(39) Double-amplitude period :

$$t_D = +\frac{0.693}{\delta'} \ (sec) ; \ (\delta' = \text{positive})$$

The relation $\frac{t_H}{T}$ is equal to the number of oscillations after which the envelope has faded to half its value, and therefore represents a *measure of stability* :

$$(40) \quad \frac{t_H}{T} = -\ 0.1103\ \frac{\nu'}{\delta'} \quad (\delta' <)$$

Similarly, $\frac{t_D}{T}$ is equal to the number of oscillations after which (with dynamic instability) the envelope has grown to twice its value, thus :

$$(41) \quad \frac{t_D}{T} = +\ 0.1103\ \frac{\nu'}{\delta'} \quad (\delta' >)$$

As regards the limits of the measure of stability (t_H/T) which guarantee adequate stability to helicopters, only very few values have been gained through experience. On the other hand, it has been possible to calculate the following values for *fixed-wing aeroplanes* :

$t_H/T = 0.5$ good
$t_H/T = 0.7$ medium
$t_H/T = 0.9$ bad

In hovering flight :

We shall conclude by determining these oscillation and stability quantities for the *hovering flight*, too. For this purpose, the coefficients a, b and c must be calculated according to equation (32), and from them, after solving the equation of the third order (31), we can obtain δ' and ν' (equation 34). In a, b and c, are derivations of the aerodynamical quantities k_w and ν, according to v and α. According to equation (9), and by substituting α for α_1, we can state for k_w :

$$(42) \quad k_w = k_a\ (\alpha + a_1)$$

and (according to Fig. 1 and equation 6) for ν :

$$(43) \quad \nu \backsim a_1$$

$$\nu \backsim a_1 \backsim \frac{v}{U}\left(\frac{k_a}{1.14\ .\ \sigma_{0.7}}\ \vartheta + \vartheta_{0.7} \cdot 1.4\right)$$

With this, the partial derivations work out at :

$$(44)\ k_{wv} = \frac{\partial\, k_w}{\partial\, v} = \frac{k_a}{U}\left(\frac{k_a}{1.14\ .\ \sigma_{0.7}}\ \vartheta + \vartheta_{0.7} \cdot 1.4\right) ;$$

$$k_{w\alpha} = \frac{\partial\, k_w}{\partial \alpha} = k_a$$

$$\nu_v = \frac{\partial\, \nu}{\partial\, v} = \frac{1}{U}\left(\frac{k_a}{1.14 \cdot \sigma_{0.7}} + \vartheta_{0.7} \cdot 1.4\right) ;$$

$$\nu_\alpha = \frac{\partial\, \nu}{\partial\, \alpha} = 0$$

For the *hovering flight*, especially simple formulae result, since the terms a and b, according to equation (32), are very small in comparison to c. We obtain therefore :

$$(45) \quad \delta' = \frac{1}{2}\sqrt[3]{c - \frac{a}{3}}$$

$$(46) \quad \nu' = 0.867\ \sqrt[3]{c}$$

whereby : $k_{wv} = a = 9.81\ \frac{k_{wv}}{k_a} = g\nu_v$

$$c = \frac{G \cdot g}{J_y}\ h_s \cdot \nu_v$$

Thus, according to (37), the period of a complete oscillation works out at :

(47) Period of a complete oscillation :

$$T \doteq \frac{7.25}{\sqrt[3]{\frac{G\ g}{J_y} \cdot h_s \cdot \nu_v}}$$

For the half- and double-amplitude periods, the following values work out :

(48) Half-amplitude period (δ' negative) :

$$t_H = \frac{0.693}{-0.5\sqrt[3]{\frac{G \cdot g}{J_y}\ h_s \cdot \nu_v}\ +3.26\ \nu_v} \ (sec)$$

(49) Double-amplitude period (δ' positive) :

$$t_D = \frac{0.693}{+0.5\sqrt[3]{\frac{G \cdot g}{J_y}\ h_s \cdot \nu_v}\ -3.26\ \nu_v} \ (sec)$$

It is discernible from these formulae that the decisive constructional quantity for influencing the stability, is the *dimension* h_s. Since h_s, in accordance with Fig. 5, is composed of the distance of the flapping-hinge plane from the C.G. (z_s) and the height of the neutral point (h), the latter (due to $h = \frac{a}{2\ a_0}$) being set by the *flapping-hinge distance* (a), this distance (a) becomes the ruling dimension for the dynamic longitudinal stability in hovering flight. In order to achieve a longer period of oscillation and less increment, or even damping, one must keep the flapping-hinge distance (a) *small*, or even make it *negative* (flapping hinge lies in the rotor head on the side opposite to the blade). As reference value, it may be stated that incremental oscillations with periods of less than 4 seconds are unsuitable from the standpoint of flying technique.

In the graphic presentations from Fig. 7 to 10 are plotted the oscillation and stability quantities, these for $h_s = 0$ to 3 metres, and $G/J_y = 2$ to 10, as well as for $k_a = 0.01$, $\sigma_{0.7} = 6$ per cent., $\vartheta_{0.7} = 12$ deg. and $U = 200$ m/sec.

In order to attain a *longest* possible period of oscillation, one must choose, as is shown by *Fig. 7*, the *neutral point height* (h_s) as *small* as possible and the *moment of inertia* (J_y) of the helicopter about the y_o-axis as *large* as possible. (The diagram features the values G/J_y plotted as parameters.) In *Fig. 8*, the " damping " (δ') is plotted. It shows *positive* values, i.e., we are dealing with an *incremental oscillation* and with no real damping (for this, equations 35 and 36). It is seen in this diagram, too, that the *smallest* increment occurs at small neutral point heights (h_s) and large moments of inertia (J_y).

In *Fig. 9*, we find the double-amplitude period (t_D) plotted, which one naturally wishes to have as high as possible, and which condition is likewise attainable by applying

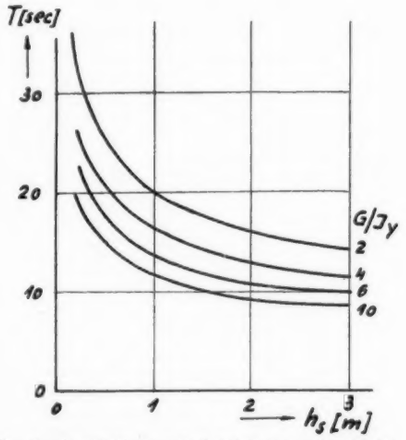


Fig. 7 : Oscillation period (T) in hovering flight.

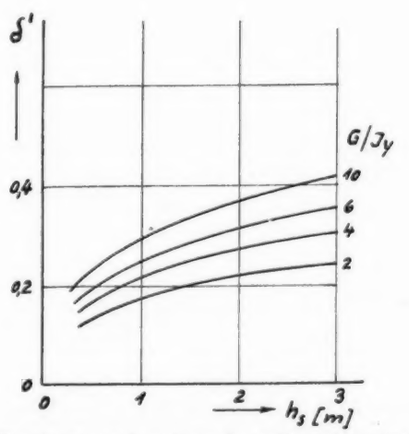


Fig. 8 : The " damping value " (δ') in hovering flight. Since δ' is positive, there is *no* damping, but *incremental effect.*

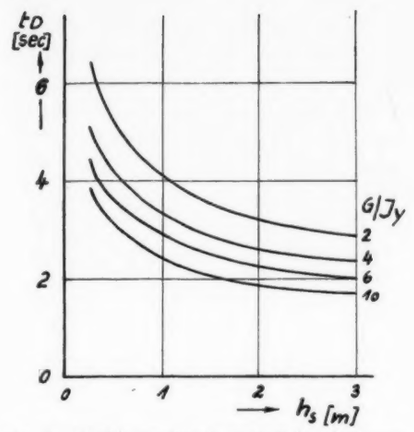


Fig. 9 : Double-amplitude period (t_D) in hovering flight.

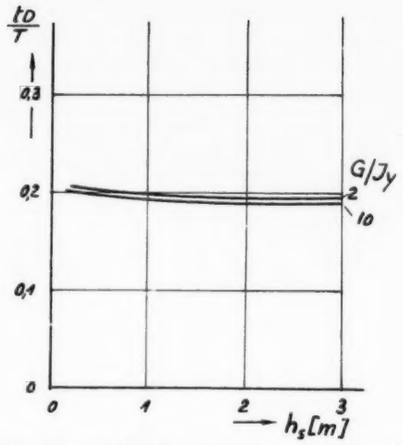


Fig. 10 : " Stability " measure, or measure for incremental effect (t_D/T).

the constructional measure mentioned above. *Fig. 10* presents t_D/T, i.e., the number of oscillations after which the envelope increases to double its value ; it amounts to approximately 0.2.

In order to present a comprehensive picture of the oscillation process and its accompanying forces, *Fig. 11* features four sketches, which should be studied in the order 1 to 4 :

Sketch 1 represents the original condition, namely, an undisturbed *hovering flight* with the C.G. position $\sigma = 0$ deg.

Sketch 2 shows a very slight forward-tilting of the helicopter, due to a disturbance, e.g., a gust. The *rotor resultant* remains, of course, in the axis of rotation and *also tilts* forwards. Thus it has no tendency whatever to retain a vertical direction, as is often presumed by the layman—it so happens that a rotor is not an air balloon. Through the inclination of the resultant, the helicopter is now accelerated *towards the left* and gathers forward speed ; no upward-directed moments exist for the present.

Sketch 3: Owing to the small forward speed which the helicopter has gathered, the resultant wanders away through the angle ν (cf. equation 43). This gives rise to a strong tail-heavy moment, which turns the aircraft back again. Thus, the helicopter possesses strong *static* stability.

Sketch 4: Owing to the tail-heavy (return-directing) moment, the helicopter has been *turned back* beyond the zero position, in the tail-heavy sense. This brings the forward progress down to zero again. Since the resultant is now inclined to the right, the helicopter gathers speed *towards the right*, and the same process is once more resumed.

In this manner, the oscillation process, which consists of a to-and-fro motion combined with a turning motion, *rocks more and more*, if the pilot does not check the rocking tendency by interceding with the controls. As long as the oscillation period is not too small, this requires, as practice has shown, no special virtuosity (one might also say " acrobacy ") on the part of the pilot. A normal helicopter, therefore, in hovering flight, has *strong static* but *no dynamic* stability.

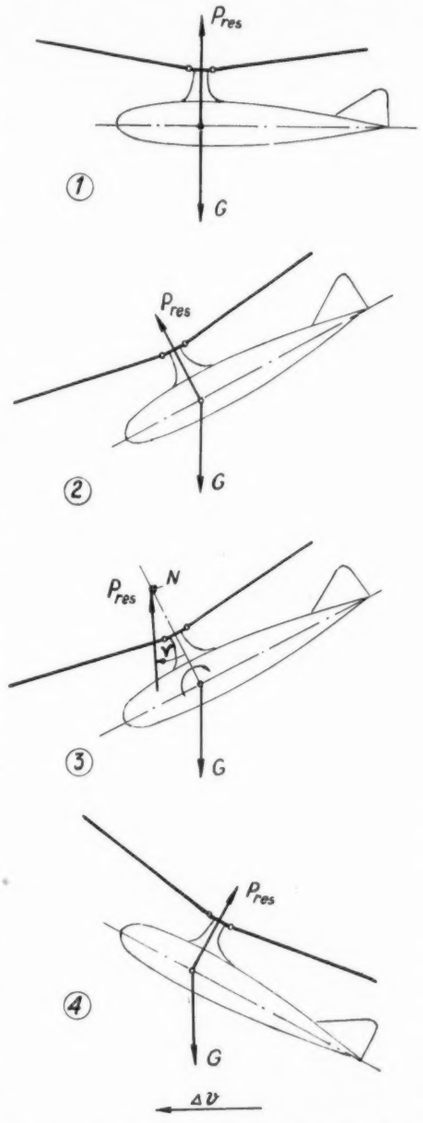


Fig. 11 : Oscillation process in the case of an ordinary helicopter in hovering flight. (Such oscillations do not occur in Bell-type helicopters, because process 3 occurs even at $\Delta v = 0$.)

More important than these types of stability are, therefore, *good control qualities*, which most helicopters all the same do feature ; and in contrast to normal fixed-wing aeroplanes, even at minimum speeds and at standstill.

TWO EXAMPLES

for the dynamic longitudinal stability.

To provide a better understanding of the theoretical explanation, the lines below cover the calculation, according to equation (32), of the dynamic longitudinal stability, for speeds of $V = 0$ km/h to $V = 200$ km/h, for two types of helicopter featuring gross weights of $G_I = 500$ kg and $G_{II} = 5{,}000$ kg. The assumed data on the two helicopters are as follows :

G	500 kg	5,000 kg	G	500 kg	5,000 kg
F (m²)	50	250	$\sigma_{(0.7)\%}$	6%	6%
G/F (kg/m²)	10	20	$c'_{a\infty}$	5.6	5.6
D (m)	7.97	17.8	k_{wv}	0.000036	0.000025
J_y	40	2000	$k_{w\alpha}$	0.01	0.01
G/J_y	12.5	2.5	ν_v	0.0036	0.0025
c_{ws}	0.01	0,01	ν_α	0	0
$c_{ws} \cdot F$	0.5	2.5	F_H (m²)	0.75	3.75
U (m/sec)	126.5	179	c'_{aH}	3.0	3.0
$\vartheta_{0.7}$	12°	12°	l_H (m)	3.18	7.1
k_a	0.01	0.01	F_c	7.15	80

Thus, according to (32), a, b and c, with $\alpha_{Ho} = 0$, work out at :

$G =$ 500 kg : $a = 0.035 + 0.0368 \cdot v$
$b = 0.00124 \cdot v + 0.0113 \cdot v^2$
$c = 0.000393 \cdot v^2 + 0.0000138 \cdot v^3 + 0.438 \cdot h_s$

$G =$ 5,000 kg : $a = 0.0247 + 0.0183 \cdot v$
$b = 0.000438 \cdot v + 0.00252 \cdot v^2$
$c = 0.000061 \cdot v^2 + 1.53 \cdot 10^{-6} \cdot v^3 + 0.0615 \cdot h_s$

The results are plotted in the graphic presentations (Figs. 12 to 15). In Fig. 12, the oscillation period (T) is plotted against the flying speed (V). It is evident that, as the speed (V) increases, the oscillation period (T) decreases, but in consequence, that the incremental effect (cf. Fig. 13) goes over into *damping* ; this simplifies the pilot's task, above all in cruising flight. However, this only occurs when a horizontal stabilisor is fitted, which, meanwhile, is never required for longitudinal control, especially as it produces no effect during hovering flight. All the same, a horizontal stabilisor will be found welcome, at least for attaining good dynamic stability during forward flight. On the other hand, in hovering flight, the horizontal stabilisor sometimes gives rise to

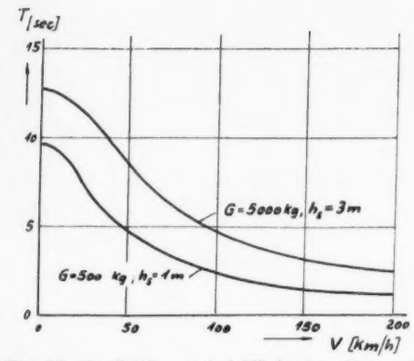


Fig. 12 : Oscillation period (T) for two types of helicopter, versus flying speed.

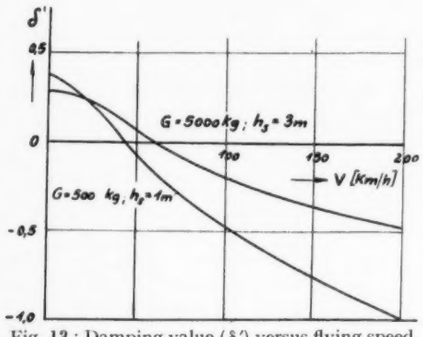


Fig. 13 : Damping value (δ') versus flying speed. (At about 50 km/h the horizontal stabilisor causes the incremental effect to go over into damping.)

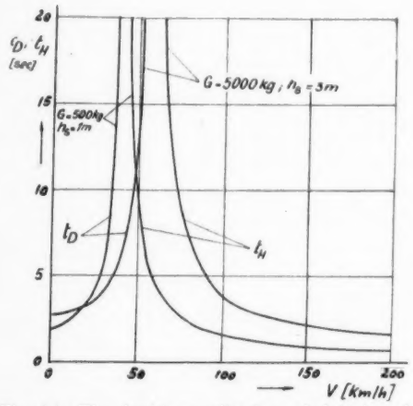


Fig. 14 : The double-amplitude period (t_D) and half-amplitude period (t_H), versus flying speed.

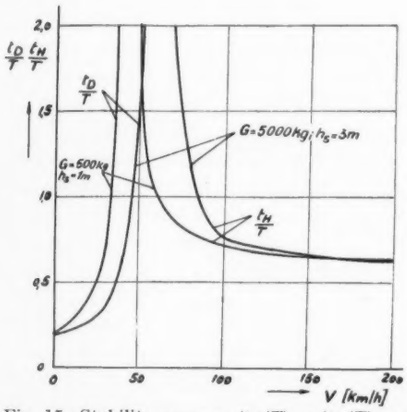


Fig. 15 : Stability measure (t_H/T) or (t_D/T) versus flying speed.

disadvantages : during windy weather, for instance, when gusts attack it and somewhat disturb the hovering flight. The half-amplitude and double-amplitude periods are plotted in *Fig. 14*. The *infinity points* mark where the incremental effect goes over to damping. *Fig. 15* features the stability quantities, t_D/T and t_H/T. It may be seen that a good helicopter, at cruising speeds, can feature stability quantities of approximately the same order as normal fixed-wing aeroplanes.

Notwithstanding the considerable degree of simplification brought into the calculations presented here, these formulae coincide relatively well with the measurement made in flight. In the case of special rotor configurations, such as those with gyro-stabilisation (Bell Aircraft Corp.), surfaces in the rotor stream, etc., these calculation methods have to be altered correspondingly. Thus, in the case of the Bell-type helicopter, for example, the stability relations are very *different*: the blades are controlled by their own torque bars, thus by a device working on a gyroscope principle, that strives to retain its position in space. If, due to a disturbance, an ordinary helicopter is tilted over forwards, for instance, then, as we have seen above (Fig. 11), the turning-back does not occur instantaneously, but only after the helicopter has assumed a certain forward speed. When Bell-type helicopters tilt, however, the blade-control by means of torque bars causes an instantaneous wandering away of the resultant—thus a turning-back of the helicopter without its having to gather forward speed—so that the Bell helicopter, within certain limits, does not feature the rocking motion mentioned above. Therefore, there is more of an analogy with the air balloon, in this instance. As practice has shown, one can fly the Bell helicopter for a certain time *without touching the control column*.

For comparing our theoretical considerations with practical experiments, much can be gained from examining A. M. Young's article (cf. footnote 2), which describes stability experiments executed on models with different C.G. positions. In *Young's Fig. 5*, for instance, the model features a positive distance (h_s) of the C.G. from the neutral point. As we have seen from the above account (our Fig. 8), it must therefore execute an *incremental* oscillation, of the kind described in our Fig. 11. On the other hand, the model shown in *Young's Fig. 7* features h_s approximately equal to zero, so that its oscillation period (T), according to equation (47) and our Fig. 7, must be *infinite*, i.e., it executes no oscillation at all, and is in indifferent equilibrium. (Blade control in this case is, of course, impossible : one has either to displace or turn the entire rotor head.) Then, *Young's Fig. 6* shows a model with negative h_s, whereby the neutral point lies *below* the C.G. The wandering away of the resultant after a disturbance yields—in contrast to our Fig. 11—a moment which tilts the helicopter *still more sharply*. Therefore, the model possesses no static stability and is consequently in unstable equilibrium. An arrangement of this kind cannot be used in practice.

For purposes of more exact calculation, one would have to take into account the following influences, among others :

gyro forces of the rotor,
inertia of the rotor stream,
more exact rotor forces, taking into account the blade torque moments.

Their discussion would have exceeded the scope of this article, since the primary intention here has been to give a clear as possible account of what dynamic stability is, together with its physical laws. [8]

As the historical development has shown, the stability and control qualities of helicopters have been the object of constant improvement. Whilst the earliest helicopters more often than not required considerable virtuosity on the part of the pilot, modern types are relatively easy to fly. *We may safely expect still further improvements of the future.*

[8] In addition to the two references given at the beginning of this article, may be mentioned : *K. Hohenemser:* "Über die dynamische Stabilität des Hubschraubers mit angelenkten Flügeln." (Ingenieur Archiv 1938, Heft 6).

Added by the editor

THE HELICOPTER IN UNIFORM FORWARD-CLIMB FLIGHT

In order to give readers who are not altogether acquainted with the partly new and partly difficult problems of helicopter aerodynamics, an *explanatory example* of the stabilising-force play during *cruising flight*, as it may be deduced from Dr. Just's analytical study, we have decided to add the diagram on the next page.

Here is shown a single-rotor helicopter, as example, with two blades, *with* horizontal stabilisor—cruising at a speed v and at a small ascending angle $\gamma \sim 6$ deg. We shall leave out the torque compensation in this example, by imagining the blades to be driven by small jet nozzles at the tips (B), as is indeed the case for helicopters designed by *Dobblhoff* and *SNCA-SO* ("SO 1100"). The blades have the usual flapping and rocking hinges, and are additionally controllable through the medium of a *blade control system* which, with the aid of a "spider", changes their angles of incidence cyclically during their rotation, with amplitude at will. If the control column is pushed for-

wards, the rotor control axis wanders (through a lever system) backwards through $+\eta_x$ in relation to the rotor axis of rotation, and thus shifts the blade angle of setting with the amplitude $-\vartheta_s = +\eta_x$ in accordance with a sinus law ($sin\ \psi$). As a result, and because of the 90-deg. phase shift due to the inertia, the *blade-flapping angle* becomes *smaller in front*, though *larger behind* (than it was beforehand because of the air stream), and the rotor resultant tilts forwards. The air stream *fore* (v_{ST}) and *aft of the rotor* (downwash) (v^*_{ST}) is illustrated with wavy lines. The influential angles of the airflow are :

for the rotor : $a = a_s + \eta_x$ (negative)

for the horizontal stabilisor :

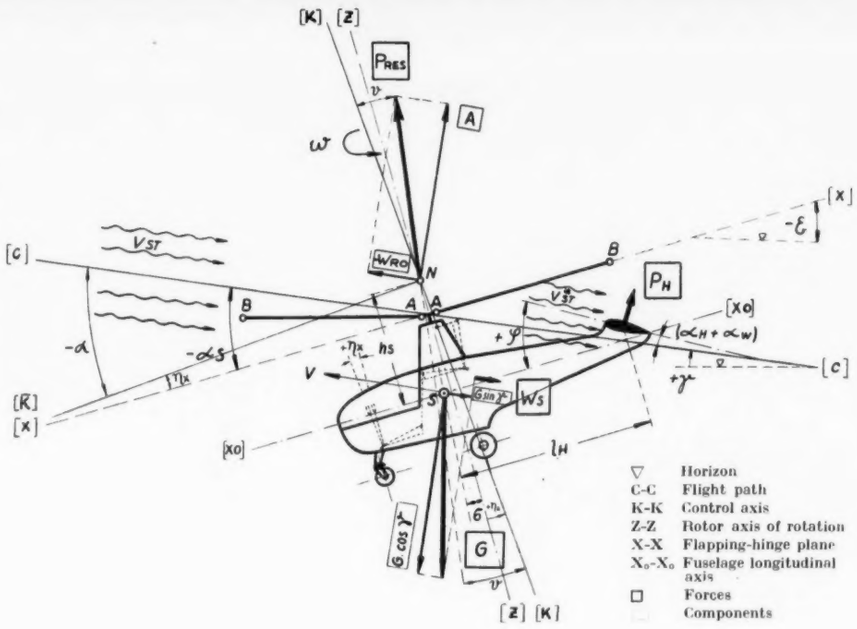
$$+a_H = +\phi - a + \eta_x - a_w$$
$$(\kappa = 0)$$

For the sake of covenience, the angle of incidence (a) for the rotor is referred to a plane (k) which is introduced perpendicular to the rotor control axis, and the angle of incidence (a_H) for the horizontal stabilisor is naturally referred to the aerofoil's plane of symmetry. In cruising flight, the angle a is *negative*. Consequently, the rotor resultant (P_{RES}), in relation to the rotor axis of rotation, is inclined rearwards (due to the blade flapping angle's being larger in front), though *in its entirety* it *leans forwards* (in relation to a line vertical to the flight path). As a result, there arises a forward-thrust component ($-W_{RO}$), which tends to overcome both the parasite drag ($+W_s$) and the weight component ($+G \cdot sin\ \gamma$). As regards the horizontal stabilisor, the small positive angle of airflow attack means that the horizontal stabilisor air force (P_H) is directed *upwards* and consequently gives rise to a nose-heavy — marked negative here — moment about the C.G. ($-M_H$), which counteracts the tail-heavy moment ($+M_{RO}$) caused by the rotor resultant P_{RES}. Calculated with the distance of the line of action of the force P_{RES} from the C.G., this moment works out at $+M_{RO} = P_{RES} \cdot sin\ (\nu - \eta_x - \sigma)\ h_s$; at such small angles, the sinus can be replaced by radians.

Since the cruising flight represented here is supposed to be uniform, all mass forces drop out, which, anyhow, only occur in the case of accelerations or rotations about the y_o-axis. Likewise, all forces centrifugal to the path are eliminated, since the flight path remains a straight line. The *four effective forces*: gross weight (G) and parasite drag (W_s) on the one hand, rotor resultant (P_{RES}) and horizontal stabilisor force (P_H) on the other, are in *force and moment equilibrium*. Thus :

1) $\Sigma(W) = 0 : A = c_a \frac{\rho}{2} v^2 F = G \cdot cos\gamma - P_H$

(P_H can be disregarded)



2) $\Sigma(H) = 0 : W_{RO} = c_w \frac{\rho}{2} v^2 F = G \cdot sin\gamma + W_s$

$$= G \cdot sin\ \gamma + \Sigma (f_s \cdot c_{ws}) \frac{\rho}{2} v^2$$

(V and H signify force components perpendicular and parallel to the flight path.)

3) $\Sigma(M) = 0 : + M_{RO} - M_H = 0\ C'_{aH}$

$$c_a \frac{\rho}{2} v^2 F \cdot h_s (\nu - \eta_x - \sigma) - \frac{\rho}{2} v^2 F_H \cdot c'_{aH}$$
$$(+\phi - a - \eta_x - a_w) \cdot l_h = 0$$

The coefficients c_a and c_w have to be obtained through relatively difficult methods ; and not very much has been gained by writing them up here. All the same, one can emphasise, in this manner, the dependence of both the rotor lift (A) and the rotor forward thrust ($-W_{RO}$) on the square of the flying speed (v^2) and on the rotor disc area (F). As is known, the parasite drag (W_s) is also dependent on the square of the flying speed, and on the drag areas and drag coefficients. The coefficient c'_{aH}, or " lift gradient " of the horizontal stabilisor, is the measure of ascendence of the latter's lift coordinates (based on the angle of incidence) and, according to the aspect ratio of the horizontal stabilisor, amounts to 0.53 (for 1 : 2) to 0.75 (for 1 : 5) for each 10-deg. change in angle, or 0.174 radians, i.e., 3 to 4.3, based on radians 1.0.[1]

If the uniform status is now disturbed, then the aircraft executes translatory and turning motions ; if we confine ourselves to longitudinal stability disturbances, this would be a rotation about the aircraft's transverse axis (y_o) at an angular speed of $\omega_y = \frac{d\epsilon}{dt}$ and a velocity disturbance $\pm \Delta v$ which we shall disregard here. A disturbing rotation in clockwise direction ($+\omega_y$) would cause an increase in horizontal stabilisor force, in view of the increase in angle of airflow attack through the angle

$$\Delta a_H = \frac{\frac{d\epsilon}{dt} \cdot l_H}{v} + \Delta a$$

and would give rise to a braking of the turning motion, later coupled with a rotation in anti-clockwise direction. As soon as the turning-back swings beyond the stationary position, it again causes counter-actions ; this time, however, in the opposite direction. In cruising flight, these influences lead to a quick returning of the helicopter into the stationary position, in the form of a damped oscillation. *A helicopter of this kind, therefore, does not only possess static longitudinal stability in cruising flight, but also dynamic longitudinal stability.*

Below are listed a few more references for the benefit of readers whose thirst for knowledge may not yet be quenched.

R. BERGEROT : " Méthode pour la détermination directe des angles de battement vertical en vol de translation de l'hélicoptère " : Technique et science aéronautiques, tome 4, 1947 ; P. 217.

H. GLAUERT : " A General Theory of the Autogyro " : Reports and Memoranda No. 1,111, London, 1926.

G. SISSINGH : " Die Berechnung der Rotoren von Drehflügelflugzeugen bei höheren Fortschrittsgraden mit besonderer Berücksichtigung der Probleme des Schnellfluges " : Luftfahrtforschung, Jahrbuch 1941, P. 351.

Ri.

[1] Data according to Fuchs-Hopf. A formula may also be used :

$$c'_{aH} = \frac{5.5}{1 + \frac{1.76}{\Lambda_H}}$$

whereby $\Lambda_H = b^2_H / F_H$ = signifies the horizontal stabilisor's aspect ratio.

THE DE HAVILLAND "CHIPMUNK"

By William Green, Stafford, England.

In the de Havilland D.H.C.1 " Chipmunk " can be found most of the prime requisites of an elementary trainer ; requirements that have been determined from many thousands of elementary training hours carried out in schools of the British Commonwealth Air Training Plan during the recent war years. It would seem a pity that the British Air Ministry's policy regarding trainer aircraft may, in the future, favour the three-seater rather the more usual two-seater formula and thus cast doubt on the possible production of the " Chipmunk " for the Royal Air Force. Nevertheless, the two-seater trainer has a number of advantages over a larger trainer in initial and operational costs, and, consequently, there exists a considerable market for a low-powered two-seater trainer.

The " Chipmunk " can be considered as the logical successor to the " Tiger Moth " trainer, the aeroplane on which the great majority of British Commonwealth pilots were trained during the war. The same engine is used, the reliable " Gipsy Major IC, " and by marrying this well-tried engine and a modern airframe, a performance more in keeping with the latest requirements has been achieved.

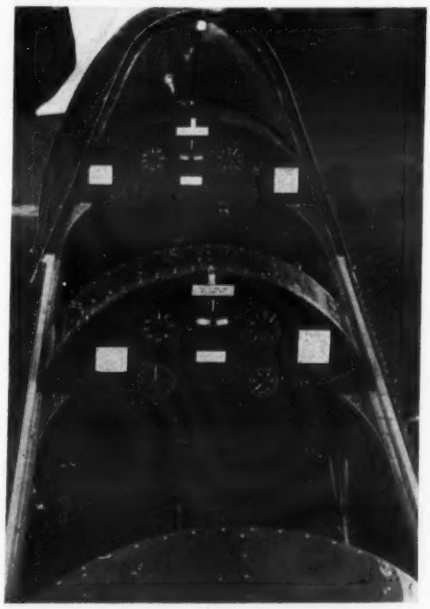
Design work on the " Chipmunk " was commenced in October, 1945. The " Tiger Moth " had by then given fourteen years of reliable service, and *The de Havilland Aircraft of Canada, Ltd.*, in Toronto, the Canadian division of the parent company in Great Britain, was determined to produce a worthy successor. The Canadian design team therefore devoted considerable study to possible layouts, and a mock-up, containing all the desirable features, was built before the general lines were decided upon. Special attention was given to ease of access, cockpit layout, canopy headroom, and general visibility, as well as to simplicity of construction.

The first prototype made its inaugural flight on May 22nd, 1946, piloted by Mr. P. Fillingham, since which date a number of " Chipmunks " have been built and demonstration aeroplanes sent to various countries. As yet, large-scale production at Toronto has not begun, but plans have been formulated ; and if European orders for the " Chipmunk " are sufficiently numerous, the type will also be produced in England. At the time of writing, the company has received its first sizeable European order for the " Chipmunk " from Belgium, who is purchasing twenty units. The Canadian price is 7,500 Canadian dollars.

General Description

The " Chipmunk " is a two-seater low-wing monoplane of all-metal construction, fitted with dual control. Structurally, it conforms

Both pilot seats are equipped with a bare minimum of instruments.



to modern practice, particularly as regards the use of the latest stressed-skin methods throughout.

A noticeable degree of simplicity has been achieved by incorporating no electric or hydraulic control systems in the " Chipmunk ." Thus the slotted flaps are manually operated from either the front or rear seat, and have a maximum deflection of 40 degrees.

In view of the " Chipmunk's " function as a primary trainer, the wing loading has been kept to 10.3 lbs. per square foot, which affords a stalling speed of 45 m.p.h. with flaps up and 40 m.p.h. with flaps down. Aspect ratio is 6.82, and the taper ratio is 2.1 to 1.0. In order to avoid wing-tip dropping when approaching stalling speed, the wing is a combination of two basic aerofoils : NACA 2415 and USA 35.B. The latter aerofoil is a high-lift section, positioned near the tip, which consequently results in an increasing camber near the wing tips.

Fuselage front section with built-in service organs for the dual control.

Constructional Features

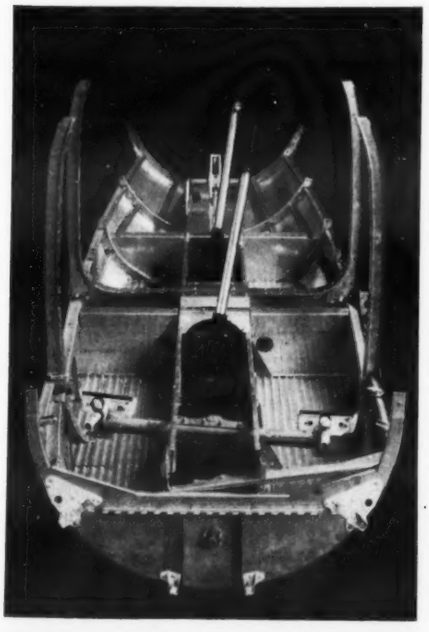
The all-metal stressed-skin fuselage consists of two major sections attached by a reinforcing band riveted to the rear section and encircling the fuselage immediately aft of the rear cockpit. The forward fuselage section is also riveted to this band and provides a simple means of dismantling the fuselage for repair purposes. The forward section—containing the cockpit—is built around four main longerons carried on pressed formers. These longerons are interspaced with a series of stringers to distribute the loads over the skin. The firewall forms the front of this section and the longerons provide strong points for the attachment of the engine-mount structure.

The main wing-attachment fittings attach to a built-up U-shaped belt frame positioned beneath the front cockpit seat. This frame transmits the spar loads across the fuselage. The third wing-attachment point—at the leading edge—is attached to a similar frame forward of the front instrument panel.

The cockpit enclosure consists of a fixed Plexiglas windscreen attached to a steel tubular structure which also serves as a crash pylon for crew protection in the event of the aeroplane's turning over. The remainder of the enclosure consists of a long hood which slides rearwards to clear both cockpits.

The rear fuselage section is conical, without double curvature, and terminates in a small bulkhead to which the tailplane, fin post, and tail-wheel leg are attached. This arrangement facilitates assembly and overhaul. A detachable tail cone is fitted.

Frame of fuselage front section, showing the three fittings for the wing attachment.



The cantilever wing is built in two major sections, each of which is attached to the fuselage at three points : at the top and bottom of the main spar, and by one shear-bolt close to the leading edge. Inspection of the attachment points is easily effected by removal of the wing fillets. Each main wing section embodies a single D-shaped box, built up by the single main spar, the nose ribs and the leading-edge skin. Spanwise stringers give added support to the skin. In addition to the undercarriage loads, the D-nose carries all the stresses. The ribs aft of the main spar are attached to the D-nose. False spars carry the flap and aileron hinges. With the exception of the walkway area, the wing aft of the main spar is fabric-covered. A " Pliocel " flexible fuel cell is positioned in each D-nose, in the portion inboard of the undercarriage mounting. The detachable wing tips are of pressed metal. The slotted flaps and ailerons consist of pressed metal ribs and spars, and are fabric-covered. A metal trailing-edge tab is fitted to the starboard aileron. The ailerons are mass-balanced internally.

The fin and tailplane are all-metal with a stressed skin. The fin post is bolted directly to the rear fuselage bulkhead, while the tailplane is carried to the same bulkhead by two front spar fittings and two struts to the rear spar. The rudder and elevators have metal spars and ribs and are fabric-covered. Trimming tabs are fitted in the elevator trailing edges and are connected to a cockpit trim control.

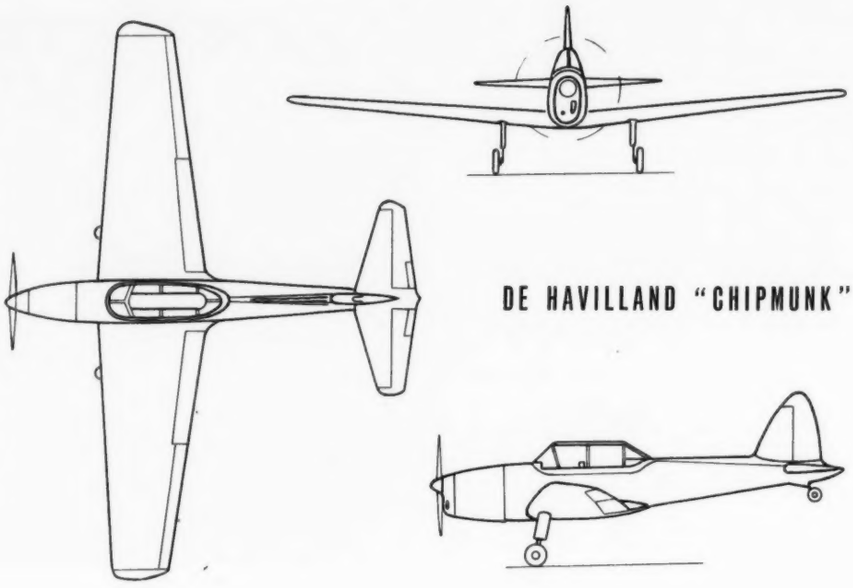
The engine mounts are formed of light-alloy tubular beams, two of which are bolted

The two main fuselage sections are fitted together.

to the upper fuselage longerons. To afford complete fixing of the engine, each member is strutted to the lower fuselage longeron. The engine cowling consists of four panels ; a fixed front panel containing the cooling-air inlet, a fixed lower panel containing the exhaust-pipe slot, and left and right hand

panels, hinged at the top to facilitate engine maintenance.

The undercarriage is of simple design, with rubber as the shock-absorbing medium. This feature, apart from its low production cost, has been found to give long life, and comparative freedom from maintenance. The main legs are carried directly into the wing nose and have no external braces or struts. The main cylinder is covered by a light, streamlined fairing. The wheels are carried on cantilever axles. The differential brakes, coupled to the rudder control system, afford ample control during taxiing. The fully-castoring tail-wheel is on a levered suspension and also uses rubber as the shock-absorbing medium.



DE HAVILLAND "CHIPMUNK"

Engine and Airscrew

The de Havilland "Gipsy Major IC," giving 140 B.H.P. at 2,400 r.p.m. at sea level, has given excellent service in the "Chipmunk's" predecessor, the "Tiger Moth," and is well-known in aviation circles for its extreme reliability. The "Gipsy Major" has official approval for 1,500 flying-hours between overhauls, and this fact is of considerable importance in calculating operating costs.

The "Chipmunk" is at present available with a fixed-pitch airscrew of either metal or wood, though it is intended to install the de Havilland manually variable-pitch type as soon as it becomes obtainable in sufficient number.

Among criticisms that have been directed against the "Chipmunk" are, the method of hood operation, the difficulty of adjusting the rudder pedals, and the lack of an adjustable seat. However, apart from these comparatively minor points, it is generally agreed that the Canadian company has produced a worthy successor to the ubiquitous "Tiger Moth," and a trainer that should prove extremely popular.

Specifications

The following data on weight and performance refer to the version powered by the de Havilland "Gipsy Major 10" air-cooled four-cylinder in-line engine of 45 B.H.P. The Canadian-produced "Chipmunk" is equipped with the "Gipsy Major IC" of 140 B.H.P., but the version built in England will be fitted with whichever engine is available.

DIMENSIONS

Span	34 ft. 4 in.
Length	25 ft. 8 in.
Height	7 ft. 1 in.

POWER PLANT

De Havilland "Gipsy Major IC" air-cooled four-cylinder in-line engine of 140 B.H.P., or "Gipsy Major 10" of 145 B.H.P.	
Fuel (two wing tanks)	25 Imp. Galls.
Oil	25 Imp. Galls.

WEIGHTS

Tare weight	1,174 lbs.
Fuel	180 lbs.
Oil	22.5 lbs.
Crew (pilot, pupil, and parachutes)	380 lbs.
Available for extra equipment	43.5 lbs.
Normal maximum all-up weight	1,800 lbs.
Maximum design all-up weight	1,900 lbs.
Wing loading	10.3 lb./sq.ft.
Power loading	14.3 lb./B.H.P.

PERFORMANCE

Maximum speed at sea level	143 m.p.h.
Cruising speed at sea level	124 m.p.h.
Stalling speed or with flaps down	45 m.p.h. 40 m.p.h.
Rate of climb at sea level	900 ft./min.
Service ceiling	21,200 ft.
Range on cruise power	485 miles
Endurance	3.9 hours

A first series of the Havilland "Chipmunks" on the Canadian company's airfield.

Safe Take-Offs in Cases of Engine Failure

Fig. 1 : Torque pressure switch of the Convair automatic feathering system, and the system's inventor, L. J. Bordelon, Chief Flight Engineer for Convair's San Diego division.

Prompted by the increasing demand for greater and therefore more profitable payloads, engineers, in their efforts to raise the standards of safety in commercial aviation, are at present bent on eliminating the unfortunate effects of those technical troubles which come under the general heading of " engine failure during take-off, " and which are so much dreaded by pilots. Naturally, this is only possible in the case of multi-engined aeroplanes, since the pilot of a single-engined type has but one choice : " Back to Mother Earth. " However, for multi-engined aircraft, too, which should still be able to climb if an engine fails, engine failure during take-off or shortly afterwards (climb-out) is still extremely dangerous ; above all, because it places very high demands on the pilot's reactions and presence of mind. *The faulty engine must be cut out as rapidly as possible*, before the propeller, now windmilling and producing a braking effect, consumes the speed excess or climbing power, burns out a piston, eventually sets the engine on fire, or before detached parts start flying about, endangering the aircraft and crew. In addition, the yawing movement produced by the windmilling drag of the propeller can be highly unpleasant.

Engines with variable-pitch propellers can be cut out by feathering the propeller blades and shutting off the fuel (and sometimes by switching off the ignition). Most of the modern variable-pitch propellers can be feathered by means of a built-in device, as, for example, in the Hamilton Standard " Hydromatic " type, which works, hydraulically ; but not without the pilot's (or flight engineer's) interceding. Hence, the pilot must first find out which engine is giving trouble ; and that is not so simple. He certainly knows immediately that something is wrong : he hears the noise interference, sees that he is gaining no headway, and feels the yawing moments on the control column. But before he can do anything about it, he has to resort to his instruments in order to discover which engine is causing the trouble. And this demands just that little extra attention on his part, which, precisely under such critical circumstances, he needs to devote to other items : keeping his course on the runway, watching for obstacles, observing the impact pressure, operating the undercarriage and flaps, etc.

The problem of obtaining certification of transports at maximum all-up weight under the U.S. Civil Air Regulations, gave birth to the idea of relieving the pilot of this care and responsibility, and providing a system for *automatically cutting-out an engine which fails*. This system, involving automatic feathering of the propeller, has already been installed in the *Martin 2-0-2* and *Consolidated Vultee " Convair-Liner "* twin-engined transports, and has proved its reliability in thorough service tests. Meanwhile, its application will not remain confined to twin-engined aeroplanes. One only needs to call to mind that the four-engined Boeing " Stratocruiser " at its maximum wing-loading for take-off of about 80 lbs. per sq. ft.—thus at maximum operating economy—requires over 5,000 feet before becoming airborne.

An automatic feathering device (of which the purpose is to think and act for the pilot) should only be effective under certain conditions :

1. if the throttle is open to 75 per cent. or more ;
2. if the engine output, despite this throttle position, has sunk below a certain value.

Thus the automatic system must not intercede if rapid opening of the throttle engages the throttle switch before engine power has been built up, nor if the engine is throttled in a natural manner ; it must furthermore remain switched off :

3. if the engine trouble is only of a temporary nature (faulty ignition, backfiring) ;
4. if another propeller is already feathered ;
5. if the pilot does not wish the automatic system to intercede.

These requirements are met by a system of switches, relays and indicator lights. Meanwhile, before going into the details in this connection, we shall describe the system itself.

Engine power, we know, is the product of torque moment and angular speed (r.p.m.). At a known r.p.m., therefore, the engine power may be expressed as engine torque, and this is—if, for measuring it, a hydraulic system is interpolated where the torque is transmitted [1]—proportional to the working pressure of the measuring fluid. If this pressure sinks—not just temporarily—below a certain magnitude, then this is signalled by the fact that the engine power, or the brake mean effective pressure (B.M.E.P.), has become so small that the propeller has to be feathered.

Below is a description of the automatic feathering system adapted to the 40-passenger " Convair-Liner " (formerly Model 240) powered with two Pratt & Whitney R-2800-C

[1] Cf. for example, the diagram of the Fedden " Cotswold " airscrew-turbine in " INTERAVIA, Review of World Aviation " Vol. II, No. 10, P. 32 (top left), where the torquemeter pinion would be coupled to the hydraulic system mentioned here.

Fig. 3 : Circuit diagram of the entire automatic feathering system.

1. Prop. feathering button and red light
2. Feathering mechanism
3. Torque pressure switch
4. Throttle switch
5. Green light
6. Test switch
7. Master switch
8. Feathering pump
9. Blocking relay
10. Battery

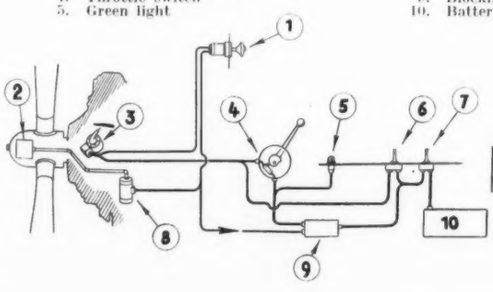
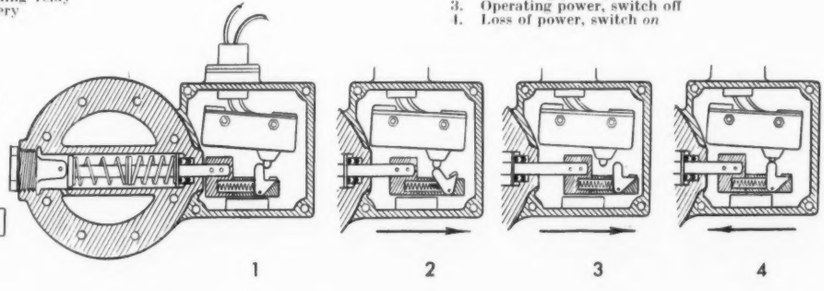


Fig. 2 : Operation of the torque pressure switch.

1. Idle power, switch off
2. Increasing power, switch off
3. Operating power, switch off
4. Loss of power, switch *on*



engines of 2,400-1,700 H.P., which is simple in construction and reliable in operation. It may be used in conjunction with both Hamilton Standard and—with slight modification—Curtiss electric propellers. The automatic system developed by The Glenn L. Martin Co. for its Martin 2-0-2 works on a similar principle and, in addition to feathering the propeller, also stops the fuel booster pump.

In the *Convair system*, the torquemeter pressure is transmitted to the pressure switch unit represented photographically in Fig. 1 and schematically in Fig. 2. It comprises a piston, and a switch operated by a small trigger. The trigger is designed to operate the switch only when the piston is returning, thus only when the engine power drops. If, at this moment, the throttle is still advanced beyond the 75 per cent. mark (condition 1), it means that the engine has failed. The torque pressure switch *and* the throttle switch then close an electrical circuit which depresses the feathering button for controlling, via the electrical pump, the hydraulic feathering operation of the Hamilton Standard propeller ; and the engine

Fig. 4 : Feathering button (and red light) for automatic and manual feathering of the starboard propeller.

is stopped in the same manner as if it were cut out manually (Fig. 3). The feathering button is on the instrument panel (Fig. 4) so that it may not only be operated automatically, but also at the pilot's discretion ; when the button is in, a red indicator light within it informs the pilot that the engine has failed and the propeller is feathering. A time delay of 1.5 seconds, from the instant of engine failure until the feathering system is actuated, is obtained by an orifice restriction in the channel supplying oil to the torque pressure cell (condition 3).

The general scheme is described in Fig. 3. On the instrument panel, a *master switch* to each engine's automatic feathering system can be turned off or on at the pilot's wish (condition 5), and a *green light* indicates whether the system is energised. Meanwhile, the automatic system cannot be effective, i.e., the actuator cannot be armed, until the engine has built up a B.M.E.P. of 143, and a corresponding high torquemeter oil pressure. The pressure switch is released again at a B.M.E.P. of 36. A *blocking relay* cuts off automatic feathering whenever either propeller is already feathered (condition 4), simultaneously extinguishing the green indicator light. Thus, the second propeller can only be feathered manually. Finally, there is a *test switch*, which by-passes the throttle switch and enables all components of the system to be checked during engine run.

Extreme simplicity and light weight form two great advantages of this system. Its main advantage, however, is that it assures take-off safety at high gross weights, therefore enabling greater payloads to be carried and higher profits to be realised.

Ri.

REGULATING METHODS FOR GAS TURBINES

By B. Gumpert and M. Haubenhofer

(Concluded) [1]

Regulating Apparatus for Gas Turbines with Indirect Registration of the Combustion Temperature

The difficulties which occurred in the course of the practical testing of German jet engines led to new regulating processes. Methods were sought which were applicable to pure jet engines and airscrew-turbines. The essential feature of these methods was that the regulating system adjusted—independent of various characteristic factors—the *quantity of fuel* to be injected in order to attain a given combustion temperature. The desired angular speed was then regulated by altering the jet nozzle area or the blade-pitch angle.

The complete regulating apparatus (see Fig. 16) fell into *three groups*, which had the following tasks to fulfil :

Fuel Injection Regulator

In dependence of engine r.p.m., pressure and temperature of the air compressor at the inlet, this apparatus fixed a certain stroke for the rod of the compressor. The influences of the *angular speed* and *temperature* were combined by means of *three-dimensional cams*. The effect of the *pressure* was multiplied geometrically, so that, in spite of the combination of three different factors, a comparatively simple mechanism regulated the amount of fuel to be injected. Noteworthy is the very accurate " dosing out " of the fuel in instances of positive acceleration. The *limiting cam* allows only as much fuel to be injected as the engine can cope with at each moment. For this purpose the effective angular speed of the engine is measured in the injection regulator and the limiting cam turned in accordance with this speed. The *control cam* is actuated directly by the operating lever, regulating the fuel amount in a state of inertia only.

Fuel Measuring Apparatus

As is known, measuring the flow by means of a fixed diaphragm or a nozzle is based on the amount of pressure-drop produced in these organs, which drop is proportional to the *square* of the amount flowing through. If this quantity is changed in the ratio of 1 : 8, the pressure drop will vary in the ratio of 1 : 64. This method would not be sufficiently accurate for small quantities of fuel flowing through, so that a nozzle with *variable cross-section* was adopted and the pressure gradient maintained constant. Adequate accuracy was obtained over the whole range of fuel quantities with this system. Furthermore, by choosing a suitable *form* of needle valve, all desired relations could be obtained between the stroke of the needle valve and the quantity of fuel. Gear pumps delivered the fuel, deviations from the calculated value of the pressure gradient being used for operating a *by-pass valve*. Variations from the specific gravity and calorific value of the fuel were easily corrected by changing the spring tension of the pressure-drop valve.

R.P.M. Regulation

For regulating the angular speed, an ordinary, serial-type airscrew r.p.m. regulator

[1] Cf. " INTERAVIA REVIEW " No. 11, November, 1947, P. 35-42.

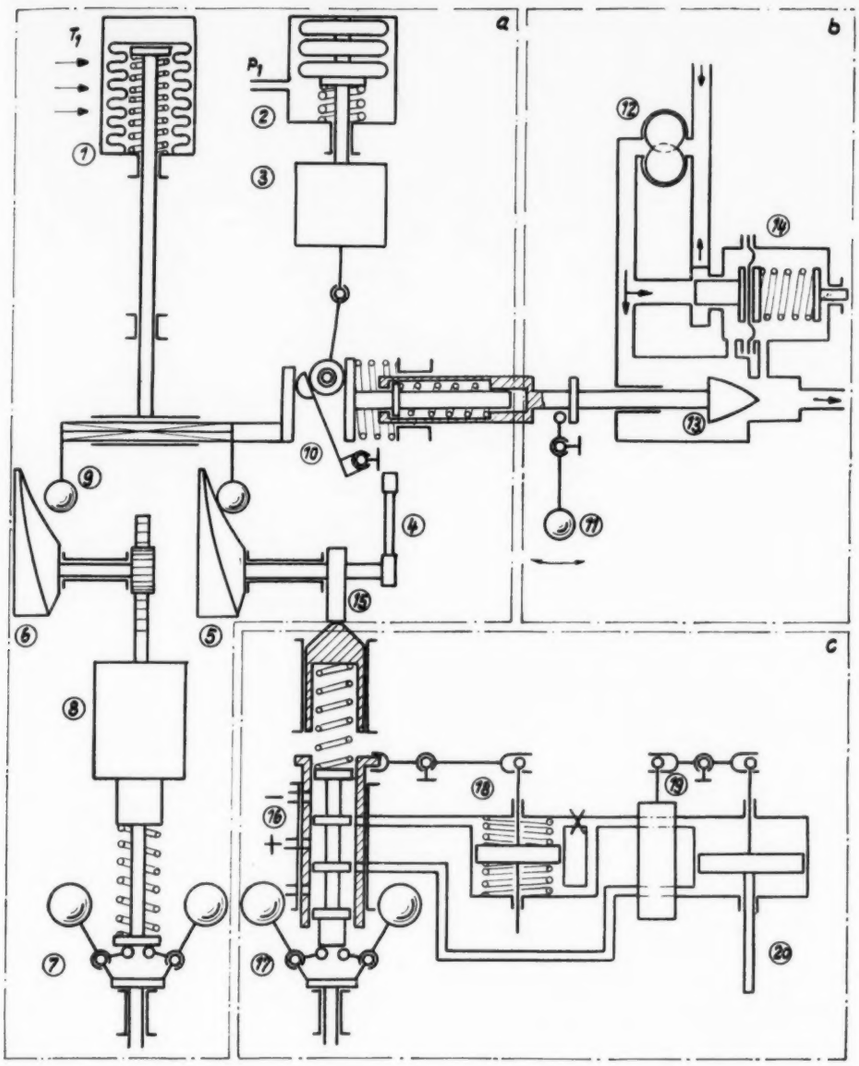


Fig. 16: Regulating system for airscrew-turbines and jet engines, with indirect measurement of combustion temperature.

a Fuel feed regulator
b Fuel meter
c Speed regulator
1. Fluid thermostat
2. Aneroid
3. Power amplifier
4. Control lever
5. Control cam
6. Limiting cam
7. r.p.m. governor
8. Power amplifier
9. Tappet
10. Multiplier
11. Stop and emergency lever
Left: *Stop*
Right: *Maximum feed*
12. Pump
13. Fuel needle
14. Pressure drop valve
15. Speed selector cam
16. Control cylinder with sleeve
17. Speed governor
18. Isodrome device
19. Synchroniser (only for airscrew-turbines)
20. Servo-motor for controlling jet nozzle area or blade-pitch angle
p_1 = Pressure at compressor entry
T_1 = Temperature at compressor entry

was used, of the kind fitted to Otto piston-engines. A sufficiently rapid means of adjusting the jet nozzle area had to be provided, and for airscrew-turbines it was necessary to incorporate a system for synchronising the blade-pitch change and the acceleration of the engine, and eliminating certain zones of pitch-angle.

These devices were studied theoretically and prototypes constructed, but never went into production. Except for experiments to test its principle, this system was never submitted to a real service test, so that it is not possible to judge its value.

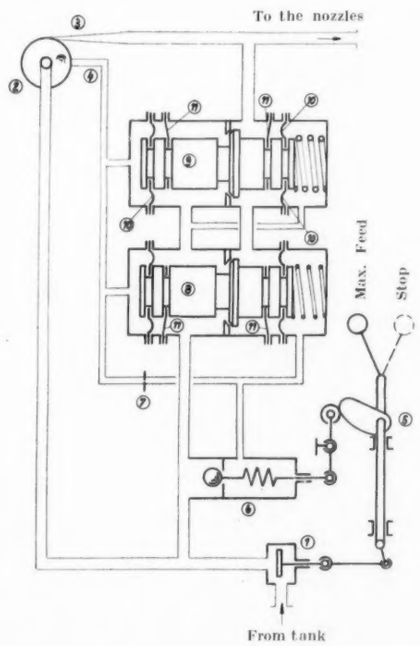
Regulating System of the BMW 003 Jet Engine

To regulate the angular speed of the BMW 003 pure jet engine, a simple, direct-action hydraulic regulator was provided (see Fig. 17). The basic idea was to use the static pressure of a rotating liquid body to furnish the regulating momentum. For this purpose a special *centrifugal pump* was constructed, the fuel circulating in the casing with the angular speed of the three-bladed rotor, and the quantity of fuel to be supplied to the injectors being drawn out by means of a diffusor. At one point the static pressure was measured, which was proportional to the specific gravity of the fuel and the square of the pump-rotor's angular speed. The *speed regulator* proper consisted of a stop valve, an r.p.m. selecting device and two by-pass valves. The stop device completely shut off the fuel supply, while the selector produced a "selected" pressure by means of a valve and variable-load spring; this pressure remained constant in the event of the angular speed's varying. This selective pressure naturally had to be less than the measured pressure and was compared with the latter by the by-pass valve, the difference between the two pressures being corrected by a spring. The excess fuel was brought back through the by-pass to the intake side of the pump. The valve body was suspended, free of friction, by sprung metal membranes; rubber membranes sealed off the measured and selective pressures so that they could not be affected by the injection and back-flow pressures. These membranes were so dimensioned as to possess equal-sized effective surfaces, and the shape of the valve seat ensured that the value of the injection and back-flow pressures did not react on the valve. A second by-pass valve was only required when the maximum angular speed was reached; it played the part of a *safety valve* which only came into action if the r.p.m. selection failed.

For controlling the *jet nozzle setting*, an electric apparatus was being developed,

Fig. 17: Hydraulic, direct-action r.p.m. regulator for BMW 003.

1. Stop valve
2. Centrifugal pump
3. Outlet nozzle
4. Pressure measurement
5. r.p.m. selector
6. Pressure valve
7. Throttling
8. r.p.m. regulator
9. Safety valve
10. Membranes
11. Spring tubs



which worked in accordance with the speed of flight and the temperature of the atmosphere.

Neither of these mechanisms was perfected to a point justifying production. Extraordinary difficulties occurred when the angular speed regulator was tested and they could not be overcome in the short time available. The system revealed its shortcomings most of all during the acceleration and deceleration. Owing to the small stroke of the by-pass valve and the complete lack of a damping system, when the control lever was moved, the engine either received the entire injection output, or the injection pressure dropped to a value which was only dependent on the hydraulic resistances of the back-flow conduit of the by-pass valve. The r.p.m. regulation was dependent on the specific gravity of the fuel. If *gas bubbles* were formed, the relation between the measured pressure and the angular speed of the pump was upset ; the regulator received entirely false pressure indications and the engine was thus greatly endangered. The r.p.m. regulator possessed a very high and permanent coefficient of irregularity. The system had to be abandoned on account of these defects, and the *Junkers*-type regulator adopted instead. The gear pump was also taken over, owing to the regulating method for idling speeds.

Tests revealed the electrical method of regulating the jet nozzle area to be insufficiently robust. For this reason, it was decided that it should be adjusted by the pilot, with the aid of a *table* and by means of an electrical multiple switch.

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Although the problems of regulating piston engines and gas turbines feature certain general analogies, the functional principles of these two types of power plant are actually very different. At the present stage of development, the two regulating methods cannot be brought into line, nor is it likely, at present, that regulating systems of universal application can be designed.

However, as the principles of airscrew- and jet-turbines are not so very different, it can be expected that a uniform system will be devised at least for these two types. The regulators which are fully effective for turbine engines with axial compressors necessitate more organs to overcome the transitory stages than those intended for jet engines with radial compressors.

The high fuel consumption requires that the engine's load capacity be used fully. The quality of the regulating system governs the exactitude with which these limits can be reached, or how small is the safety margin caused by the system's inexactitude. Undoubtedly the greatest accuracy is given by direct determination of the loading limits ; and this represents the solution to be sought. At present, the problem is only partly solved, since great difficulties are encountered in the direct measurement of the combustion temperature. Not only is the high-temperature measurement itself difficult, but it is also necessary to measure the *mean* temperature. Measurements have shown that the isothermal lines plotted at the turbine outlet clearly reproduce the combustion chambers. It would therefore be necessary to dispose over a great number of measuring points on the periphery and the radius, and to use, for the regulation, the mean value of all the measurements. It would also be necessary, in order not to exceed the temperature limits during acceleration, to measure the combustion temperature instantaneously, i.e., *without inertia*. However, as can be seen from Fig. 18, the mixture of combustion air with

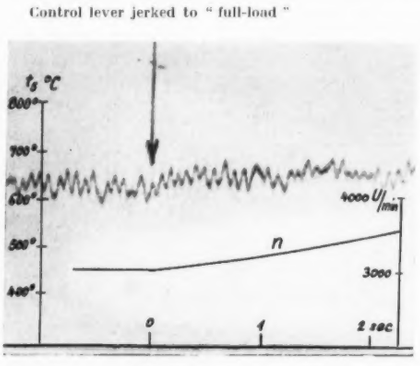

Fig. 18 : Curve of temperature at turbine outlet t_5, measured with high-sensitivity thermal element.

Note the large temperature fluctuations caused by unconcluded mixing of gases.

cold air has by no means been concluded at the turbine outlet. Despite the extreme sensibility of the registering thermal element, the real temperature fluctuations were considerably in excess of the measured values. Perfect temperature measurement therefore requires instantaneous measurement of the mean combustion temperature, with adequate accuracy.

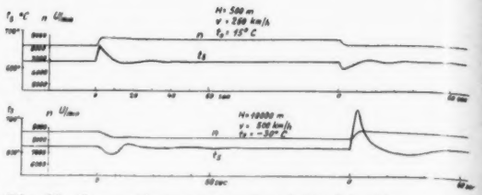

Fig. 19 : Curves of gas temperature behind turbine, t_5, with direct temperature regulation. State of inertia upset by jerking of control lever.

Junkers 004.
Normal Junkers speed regulator without fuel limiting. Direct temperature measurement and regulation by adjustment of jet nozzle area.

A partial result of theoretical attempts to solve this problem is shown in Fig. 19. The jet nozzle of a Junkers 004 engine was regulated by means of a hydraulic temperature regulator with a mechanical feeler for the temperature. The exhaust temperature, set by the jet nozzle, was *constant*. The temperatures were not measured without inertia.* The curves were plotted from altitude test-bed runs, and reveal the utility of direct temperature measurement at least for regulating the state of inertia.

Until the problem of temperature measurement has been satisfactorily solved, systems will be designed which measure the combustion temperature *indirectly*. The difficul ies are not slighter, in this instance, since the engines, even those of one series, are never exactly identical and, moreover, also change during operation. A thorough knowledge of the engine is mostly necessary, which means that a regulating system cannot be designed before an engine has been tested and its characteristics determined. If full output capacity can be dispensed with, then, of course, more simple regulators are possible. Under such conditions, systems which are not yet fully mature can be made to function fairly adequately with the aid of auxiliary devices.

As we have already seen, it is more difficult to regulate the *airscrew-turbine* than the pure jet engine. Sizeable technical problems arise in connection with airscrew braking. Its use is so advantageous, however, that the possibility of airscrew braking is an essential feature of modern regulators for airscrew-turbines. To solve this problem, considerable use can be made of the knowledge and experience gained with piston engines. It is also conceivable that existing airscrew regulators may ultimately be equipped with appropriate auxiliary devices.

* In view of the feeler's inertia, the regulating process requires a certain period of time to expire. Short-lived acceleration processes, for instance, cannot be regulated completely for this reason. For increasing the adjustment speed and the stability, quick-acting mechanical temperature-impulse devices must be incorporated.

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The giant eight-engined "Hercules" is readied for launching. Cables have been secured to the hull and Howard Hughes is supervising the creeping-out process from a platform on top of the boat.

"Hercules" Flies!

By SCHOLER BANGS

Los Angeles, November 2nd, 1947.

To one who at Bikini felt as if body and mind were a composite of over-wound watch springs, while awaiting the dreaded, exciting second of the lagoon's upheaval, the Sunday afternoon of November 2nd produced a closely similar, if moderated, reaction.

Grey beneath a grey sky, the silver-painted wood hulk of Howard Hughes' flying-boat wallowed with majestic slowness at the mid-reach of Los Angeles Harbour.

Long months of controversy over whether the world's biggest aeroplane would float, capsize, split open like a flimsy matchbox under the fist-hard blows of choppy waves, or ever become airborne, had produced their effect.

Fifty thousand persons at the least, and probably more, blackened the sea-slippery rocks and slopes of harbour moles and break-waters. Thousands more crowded the decks of a veritable Sunday regatta of harbour sailing craft, dirty little fishing boats, motor cruisers, water taxies and yachts. The former Morgan yacht, "Corsair," now commercial and running luxury cruises down the Mexican coast to Acapulco, slipped in from the ocean and was halted just within the harbour to stand clear of the testing area. Low overhead, a vulturous covey of news photo planes flew in a tight, waiting circle, and, lower still, a red helicopter hovered.

Never in aviation history had so many come from so far to wach the first sea wetting of a flying-boat, or the first testing of any aircraft for that matter.

They had come, drawn to the focal point of the headline news of the day, with Hughes' 24-hour-fresh warning that he would not fly the boat until March or April. There was no reason to believe that within the space of two hours they would see him gamble his personal reputation with one quick gesture, and risk the damning ridicule and attacks of Owen Brewster and his companion members of an inquisitorial U. S. Senate committee.

To newspaper reports and photographers, radio commentators, and newsreel cameramen, it was a "must" show.

Anything might happen. It might have its

hull ripped open before it got clear of the graving dock, and sink on the spot. It might lean wearily over, top-heavy, and bury one wing in the water. The freshening wind, that had small craft warning flags flying up and down the coast, might slip under one wing and lift it high and send the big boat, torn free from lines, sailing down upon the harbour docks and the black side of a freighter cargoed with 400 tons of dynamite. And if it got as far as a taxi run, and up on its step, it might yaw and charge down upon the milling little pleasure boats at either side; might snag its hull on a driftwood log and founder; might begin a porpoising that would end with a heavy leap into the air and a crushing plunge nose first into the waves.

At dawn they began arriving: close on a hundred reporters and cameramen from as far north as San Francisco, and from Washington, D. C., where Hughes had handed out invitations to reporters who had "covered" the opening phase of his Senate hearing.

I knew, I believe, what was in Howard Hughes' mind.

Drinking coffee with the speculative crowd huddled under the canopy of a massive "press tent," and looking at the boat, riding quietly at its choppy anchorage, I was certain that the "news" of the day would be a complete surprise.

The "ride" of the hull at rest, its balance; the smooth and sweeping lines throughout its whole structure were a confirmation.

There came a strong recollection of another aeroplane that had in it the appearance that it couldn't help but fly, and do it well.

The sight of the Hughes boat recalled an extreme comparison with a tiny jet-black Caudron racer on the ground after winning the Thompson Trophy-race at Los Angeles Airport in 1936.

My question to Michel Detroyat was probably naive: "What makes it fly so well, so fast?"

He thought for a moment, and then smiled happily, and answered: "Because she is exquisite. She is ... how would you say it?... like a beautiful woman; like a lovely dancer."

There was little of viewing the Hughes flying-boat as a thing of beauty, however, when the yacht of follies showman Earl Carroll, the "Vanities," rented for the day by Hughes as a camera boat, drew to dock. A wartime Navy crash boat, PT class, she was the fastest craft available to help cameramen keep their lenses trained upon the flying-boat during a fast run, and would do 40 knots and could be whipped about almost on beam ends in an evasive turn if need be.

As we moved out to begin a steady circling of the flying-boat during its tow out to the outer harbour, newsreel cameramen were wiring their camera tripods securely, heavily, to the deck. Newspaper photographers shifted about constantly, swinging Speed Graphics to test view and range, picking choice locations to brace backs and feet against a "Hard over!" shout from the pilot.

Photographers hoped that they had drawn a more capable skipper than the pilot of the other PT boat that had taken them off shore the previous day to "shoot" the launchings of the boat. He had been new to the power beneath his decks, apparently, and had been afraid to try to bring the torpedo boat back to dock. They had circled the channel for an hour, and finally the boat decided the issue by quietly running out of gas. Small launches finally had brought the irate photographers ashore to the chorused chant of regrets from Hughes' employees.

The business of sweating out a "top news" event, that might become just a bit grim, began. The whirr of a newsreel camera motor, testing, brought a quick circle of clear space for the sweep of the moving lens. Still photographers checked and re-checked their Graphics, and fired "background" shots of crowds pouring out upon the breakwaters. Hughes structural engineers and aerodynamicists were aboard, attempting to be casual in the eyes of their "boss," standing on a platform atop the flying-boat hull and directing tow-boats with a walkie-talkie radio. An observer for the National Advisory Committee for Aeronautics shrugged his shoulders to most questions. His wife was the only woman aboard.

Out of the inner harbour, and with the nearby flying-boat cast free and engines firing in slow succession, the pilot of the "Vanities" convinced his passengers that he was no Sunday driver, and that he knew the question in their minds.

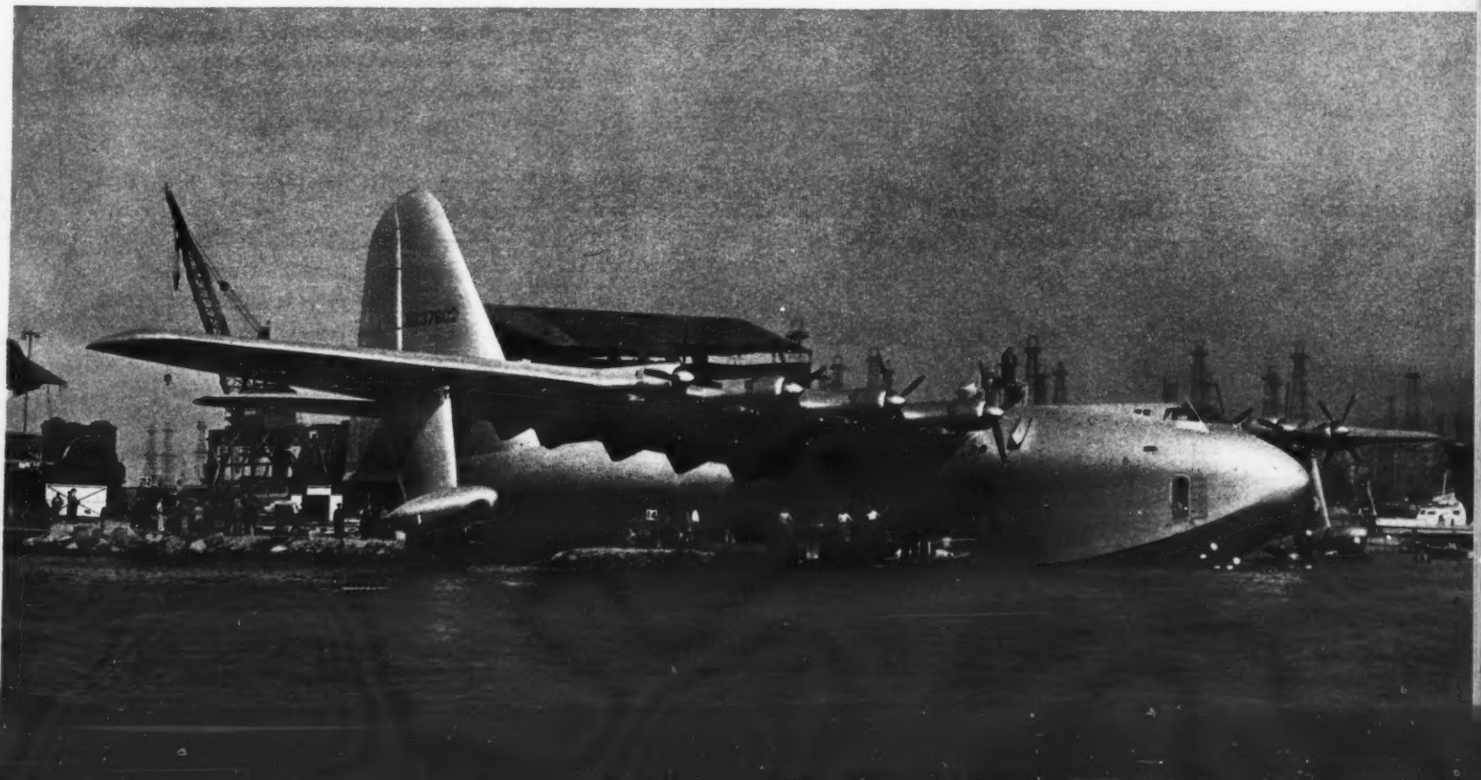
He was slight, and wiry, and "Duke" was all that he was ever called; and he asked his engineer to have all hands, all cameramen and other passengers, forward to hear what he had to say:

"This ride may get a little rough, and there are some things you ought to know. We're going to stay in close on the course, and keep ahead of the flying-boat as long as we can, to give you good shots as she comes by.

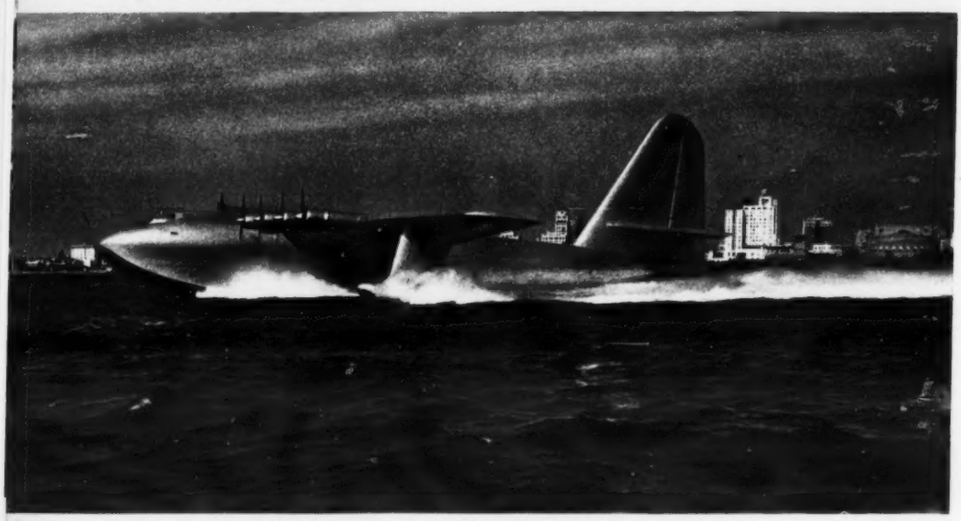
When Hughes starts to open up we are going to do the same, and we're going to go fast. You'll want to hang on.

We don't exactly know what is going to happen.

Last stages of the launching operation from the graving dock.



Before the engines have been started.



Full take-off power of the eight engines rip the colossal flying-boat across the harbour.

The step's showing!

She's made it!

I may have to make some pretty sudden turns, and there won't be time to say 'please'. As much as you can, I want you all to keep your positions when we're under way. If something happens to the flying-boat, I don't want you all rushing to one side. This boat heels over pretty steeply in a sharp turn, and would lay over even more heavily if you're all on the outside of the turn.

She won't roll over, but she may get a little rough.

Now, if anything goes wrong, I'll try to keep you out of trouble. But, whatever happens, don't jump overboard. The screws on this packet are four feet in diameter, and it would be hard to get away from them. But, if you do go over the side, try to get away as fast as you can . . . or dive deep and count a long 'three' before you start coming up.

You can smoke on the free decks. No smoking in cabins or in the after deck well. Our Packard engines are using high-test aviation gas, and we're like a floating bomb.

That's all I have on my mind, except that here on deck are enough Mae Wests for all hands. I hope you get good pictures."

This gave promise of being somewhat different from watching, at the end off the runway, with room to run in the direction of one's choosing, the Northrop YB-49 jet bomber bearing down on its test flight take-off.

"Duke" turned the wheel over to a steward while he draped the yellow horseshoe halter of a Mae West over the shoulders of the N.A.C.A. engineer's wife, and explained the emergency cord that would fire the CO_2 inflation cartridge.

A photographer stooped to the pile of Mae Wests, and then thought better of it. Too bulky. Thinking, probably: "I'd look silly putting on one of those things. Damned if I'll be the first one. Let someone else start it." No one chose to do so.

Doors in the Hughes boat hull were swung shut. An arm reached up and pulled down an escape hatch above the flight deck.

Sitting braced amidships, a walkie-talkie operator shouted up to "Duke."

"I think he's ready. This will be a straight run, probably not fast."

Across the water came the booming roar of the flying-boat's eight Wasp Majors.

Swinging into position off the flying-boat's port wing, our camera boat surged ahead, keeping pace with the big boat in jolting jumps.

The sea breeze was a good 20-30 knots. "We're doing thirty," shouted Duke. Rough spray lashed out from under the bow of the

For safety, plastic balloons are stored inside the hull. This shot, taken looking from the rear towards the flight deck, gives a good idea of the size of the "Hercules."

flying-boat, but failed to rise to the discs of the propellers.

There was a seemingly ponderous slowness to the flying-boat. At our fair distance of separation, several hundred feet, it seemed to be not very big—until you looked at it through the finder of a camera and found that in the tiny rectangle you could squeeze no more than three-quarters of its bulk.

Slowly at first, and then faster, without seeming to follow the conventional flying-boat pattern of "sitting back on its haunches," the Hughes boat began rising out of the water. Rough spray smoothed to become a well-developed bone-in-the-teeth ; and then the looked-for break in the lower hull line appeared.

Duke shouted : "She's on her step. Get it while you can !"

With the flying-boat now going away, and our own doing 40 knots, we swung in closer toward the milky wake, and out again as Hughes throttled back, his boat settling evenly and slowly back into the water.

That was at 12.10 p.m. . . . the first, and successful, try-out of the aeroplane which the most pessimistic had expected would rot in its dock.

Back to the starting line, and under way again at 12.40.

Hughes watching the flight engineer at work.

This time the massive elevators on the tail tilted slightly upward, and amid a burst of spray the hull clawed its way up out of the water and levelled off quickly upon the step, gaining speed and passing us at a good 20 knots above our own top speed.

This was the run that had the Hughes engineers crowding cameramen for rail space aboard the "Vanities."

For them it was the pay-off of their slow, painstaking years of cut-and-try, glue and smooth.

There was no way, on our bouncing boat, to tell the effect of the sea-chop beating the flying-boat was taking ; no way to judge the flexing of the wing, or the whipping, if any, of tail surfaces that seemed to attach precariously to the slender taper of the monocoque structure sweeping back from the after-hull.

But the wake was as straight as a ruler. No yawing was discernible. Nor any slightest sign of pitching that might have warned of a tendency to porpoise.

The big moment : Hughes gives full throttle.

In the excitement, Hughes let the port wing drop until the left wing-tip pontoon struck water and dragged there in the trough of a high and curling spray. But, there was no indication that the drag was perceptible to those on the flight deck.

Would control surface action be instant, when ordered ?

That was the "sixty-four dollar question" of the moment. Taxi tests had been delayed months while Hughes engineers removed a network of long hydraulic elevator, aileron and rudder control lines leading to master cylinders nested directly beneath the central flight controls. There had been evidence, in dry-dock tests, of a serious control surging, a delayed and then aggravated response of control surfaces following initial application of control movements at the flight deck. Master cylinders were re-located directly at their respective control surfaces, and cables then run from the flight deck controls to cylinder valves.

It worked, apparently, for suddenly the flying-boat veered into the start of a sharp surface turn, straightened out, and then settled into the water after narrowly missing a crowded water taxi that had wandered upon the course and had been seen almost too late upon the expanse of the harbour spread before the flying-boat's high-riding nose.

To the Hughes engineers, their brief glimpse of that flat and frothy wake, the low and thinly-sweeping bow-wave, gave the emotional lift that some get from an old painting or a majestic symphony. They just stood there, grinning and happy, as the "Vanities" circled round and round the boat until Hughes leaned out the office window and aimed the stubby aerial of a walkie-talkie in our direction.

Howard Hughes gives a big grin after coming ashore from his successful first flight in the big boat.

"He says that the next one will be straight on from here toward Cabrille Beach, and he'll make it a fast run this time and then go back in if you get your pictures. If you don't get what you want, he'll do it again."

We showed our fantail, at that, to Hughes, and scurried half way down toward the beach to sit it out, and wait a full hour for the Coast Guard boats to clear the path.

I knew, then, for certain, what was coming.

Hughes is one of the most whimsical and thoughtful persons you'll ever meet.

Through the haze of sudden awakening, at two o'clock in the morning, I've heard his voice in my telephone :

"This is Howard Hughes. You asked me certain questions two weeks ago, and I couldn't tell you the answers—then. Now I can . . ."

To all watching the launching of his flying-boat on November 1st, he had said there would be no flight before "March or April."

He wanted no disappointments.

But the next day . . . what he felt through his hands, his feet, the seat of his pants, bouncing and rumbling along the harbour waterway, he liked.

If she still behaved herself, climbing up on to the step, the next time . . .

But, still he didn't want to come right out and put himself on record with the promise of a flight that might fail.

It would be a "fast" run this time ! Let them figure out whether his boat could taxi any faster and still stay on the water !

What looked like white burst of explosions beneath the wings were clouds of spray whipped up as Hughes opened the throttles to take-off power and pulled the boat's nose up sharply.

"She's coming, coming fast !"

Again our camera boat spurted forward in its losing race as motion picture cameras swallowed the full spectacle of the flying-boat coming, seemingly head on.

"On her step !"

And then . . .

Hughes, I think, would have enjoyed the vocal explosions that came from photographers busy shooting the "fast taxi run."

"Jesus ! She's in the air !"

"Look at the bastard go !"

Newsreel cameramen and newspaper photographers live and breathe the unexpected.

That, perhaps, is why they're poorly prepared to produce a schooled expression of pleased surprise when the casually exciting suddenly blossoms into top headline news.

But, they can never say that Howard Hughes didn't tell them exactly and precisely what he had in mind to do.

A Suggestion by the

AÉRO-CLUB DE FRANCE

RECONNU D'UTILITÉ PUBLIQUE

6, RUE GALILÉE
PARIS-16e

Paris, le 26 Octobre 1947

Monsieur le Rédacteur en Chef,

L'Aéro-Club de France, préoccupé de mettre en oeuvre
les moyens susceptibles de favoriser le développement de
avait étudié pendant les hostilités les
l'utilisation des

Abolition of Airworthiness Certificates for Touring Aircraft

Paris, October 26th, 1947.

To the Editor of Interavia Review,

Sir,—Anxious to apply every means likely to foster private flying, the Aero Club of France examined during the War the best conditions under which private flyers and clubs could resume their activities. One of the measures under consideration is the abolition of the certificate of airworthiness for touring aircraft, and its replacement by a liability insurance in favour of non-participant third parties; like in marine insurance, the premium would be in proportion to a figure set by a company of surveyors.

With the full support of the manufacturers grouped in the "Union Syndicale des Industries Aéronautiques," the French Aero Club then requested the F. A. I. to communicate this suggestion to the ICAO, assuming that such a step would be likely to enhance the prestige and authority of the F. A. I.

After a very friendly discussion, the F. A. I. adjourned this proposal, expressing an opinion that such an important question should first be examined in great detail before the F. A. I. could adopt a policy which was in direct opposition to customs of long establishment.

It is the opinion of the Aero Club of France that this examination, the necessity of which it does not dispute, should be undertaken as rapidly as possible, since it anticipates significant results therefrom and believes that the later the suggestion is submitted to the ICAO, the lesser will be its chances of being adopted.

The Aero Club of France estimates that the best way to set the scene for a clear understanding of its opinions, is to have them communicated to all interested through the channel of "Interavia Review," the official organ of the F. A. I., which is read in all countries.

With this in mind, the Club is enclosing a note outlining its standpoint, and hopes that its publication will give birth to the necessary discussion.

Yours faithfully,

The President:

Together with this letter, the President of the Aero Club of France sent us an exposé of the argument on which he bases his proposition, which was put forward very skilfully by the French delegate, Monsieur P. Grimault, at the meeting of the *Commission Sportive* of the F. A. I. :

The obligation that all aircraft should be provided with an international certificate of airworthiness, corresponding to certain minima technical requirements, is in accordance with Article 31 of the Chicago Agreement of December, 1944, which repeats the provisions adopted by the ICAN in 1919.[1]

In those days, flying was still considered to be a dangerous undertaking. At the present time, it has finally come to be regarded as a normal activity. The only duty of Governments with respect to safety in private aviation, is to assure the protection of non-participant third parties against eventual accidents. This proposition seems to be indisputable from the international standpoint. The fact that aircraft are not permanently in contact with other persons or other property makes them, in this respect, much less dangerous than automobiles, so that their being treated in a special manner is not warranted.

Then, the certificate of airworthiness offers third parties a security which is only very illusory. If its technical minima are very much below the normal constructional standards, it is useless; if it were wished to embody really effective regulations in C. of A.'s, the slowness of international procedure would make it impossible to keep them up to date.

The United Kingdom delegation to the 18th conference of the ICAN in Antwerp, 1930, remarked that the eight years of work on the regulations had not yet been concluded, and that a number of the decisions taken would have to be revised on certain points.

The head of the U. K. delegation, the late Air Vice-Marshal Sir Sefton Brancker, underlined that the safety was affected neither by this lack of regulations, nor by the technical standards of certain countries. He concluded that it would be preferable to adopt the principle of liberty and reciprocal confidence, rather than international compulsion.

Statistics recently promulgated by the U. S. National Safety Council reveal that, of accidents investigated, six per cent. could be ascribed to airframe deficiencies and eleven per cent. to engine trouble. Thus, the equipment is one of the rarest causes of accidents.

This fact is confirmed by the attitude of the British and French Governments, who allow certain aircraft to navigate over their territories, which do not meet with the C. of A. standards, without this having resulted in any serious inconveniences to date.

Moreover, the C. of A. cannot cover all aircraft usage conditions (flights over water, desert and mountainous regions) and, still more important, it offers no legal guarantee, either to the proprietor and occupants, or to third parties. The ICAO seems, incidentally, to have realised the necessity of formulat-

[1]) Art. 31, of the International Civil Aviation Convention, Chicago, Decembre 7th, 1944: Every aircraft engaged in international navigation shall be provided with a certificate of airworthiness issued or rendered valid by the State in which it is registered.

Art. 11 of the Convention Relating to the Regulation of Aerial Navigation (ICAN), Paris, October 13th, 1919: Every aircraft engaged in international navigation shall, in accordance with the conditions laid down in Annex B, be provided with a certificate of airworthiness issued or rendered valid by the State whose nationality it possesses.

ing regulations on a more elastic basis, since it has approved the principle of different regulations for the separate categories of aircraft [2] and, as regards private aircraft, appears to be content to abide by the conditions formulated by each separate State.

However, these do not guarantee in any way that damages will be compensated, and do not eliminate the complications caused to international aeronautical commerce by the lack of uniformity in technical regulations.

The liability insurance in favour of third parties, with the premium scale fixed in accordance with a figure set by a company of surveyors, enables both questions to be solved and, simultaneously, clearly indicates to users the relative value, from the point of view of operational safety, of the various aircraft entering into consideration.

[2] Cf. report on the session of the Airworthiness Division (AIR) in the ICAO Bulletin of May, 1947.

In view of their commercial character, such companies of surveyors tend to adopt procedures that are far more mobile than those of public administrations, and their independence makes it possible for them to adapt themselves immediately to new technical developments. Since such companies already control shipbuilding in nearly all countries, it would not be a difficult matter for them to exercise an analogous activity in the field of aircraft construction.

On the other hand, experience shows that obligatory insurance will become indispensable anyhow, since even a country as well organised for tourism as Switzerland, has found herself forced to introduce it for automobiles, notwithstanding the difficulties due to the lack of international agreement on this point.

The superposition of the C. of A. and the insurance, is useless, and it would be wiser to adhere to the latter, which, being the only efficacious procedure, is quite sure to find introduction sooner or later.

If an aircraft is sold to a commercial operator, then it would still have to be provided with a C. of A., but the regulations would in any case be different, depending on the particular use the aircraft is put to, and the regulations relative to commercial aircraft are not applicable to private aircraft.

In practice, the proposed abolition would be expressible in the form of a small addition to Article 31 of the Chicago Convention. In view of the present state of private flying, which is being reborn from its ashes, and the work of the ICAO, the moment seems to be particularly propitious for establishing new regulations. The F. A. I. seems to be the ideal organisation for grouping all private owners of aircraft and demanding all the liberties which would assist the development of this branch of aviation.

From the start, the French suggestion makes it a condition that international safety regulations relative to private aircraft, only be attributed the task of protecting third parties against the consequences of accidents. It is prepared to regard this protection as assured, as soon as there is a guarantee that the eventual damage will be compensated in cash, i. e., as soon as the aircraft owner is sufficiently well insured against any claims which would be within the civil rights of a third party. And since this point brings international regulations into the argument, we must first set aside the question of whether it belongs to the duties of a State to forbid its nationals—in this particular case, private pilots and their passengers—to commit inconsiderate acts, such as flying un-airworthy aircraft which place their lives in danger ; it would be for the individual State to make its own decision on this point, in accordance with its own legal and moral conceptions. At present, it is a different question which is up for discussion : what measures ought States to adopt, on a reciprocal basis, in order to protect themselves against the danger created by foreign private aircraft that are not airworthy ? Should each State abide by the custom hitherto upheld, of using its sovereignty to guarantee public order, in the widest sense of the term, against any disturbance caused by foreigners, or should it confine itself to protecting its nationals' property by means of regulations based on civil law ? To name a concrete example : what measures ought to be adopted as a protection against the danger of a foreign aeroplane's crashing on a runway owing to a weak undercarriage, or instability with the flaps down, and thus disorganising traffic ? Should, in such a case, the aircraft be forbidden from the start to enter and fly over the territory, and above all to effect a landing, or would it be sufficient to demand that its owner or his insurer furnish a guarantee that full compensation will be made for the anticipated accident ?

In answering this question, we must consider that an accident of this nature can sometimes cause only property damage, sometimes a more or less serious disorganisation of public services which need protecting—particularly airport and airline operations—and sometimes even the loss of human life. In the first instance, a compensation in cash or kind would be acceptable and a liability insurance sufficient ; in the second instance, such an insurance cannot indemnify all those indirectly affected ; and in the third instance, we can only ask ourselves whether the social value of private flying justifies irreparable sacrifices : if not, then no authority responsable for the safety of a State's nationals can be expected to renounce protective measures based on civil law, in favour of regulations that are dependent on a simple liability insurance.

Now the protective measures to which States have access include the establishment of certificates of airworthiness, which the signatories to the Chicago Convention agreed to make obligatory. If we concede that certain regulations relative to aerial navigation are necessary in order to prevent accidents, then we must also ask whether it is not superfluous to surround such regulations with a complicated system of controls and acceptance certificates in order to make sure that they are respected, or if it would not be sufficient, instead, to threaten offenders with penal sanctions. But the aircraft owner, who constitutes the only person whom we would have the right to penalise in this instance, seldom possesses sufficient knowledge to be able to judge the airworthiness of his machine by himself,—whether it conforms to the regulations relative to structural strength, for example. The official certification provides him, and his passengers even more so, as they are certainly also interested in the good quality of the aircraft, with a certain peace of mind. In a foreign country, moreover, a certificate of airworthiness established in accordance with international norms is of added importance, in the sense that it constitutes a declaration by the Government of the country where the aircraft is registered to that of the country to which it is flying, that the aircraft is airworthy. Such a declaration could not be made if the adherence to the legal prescriptions only involved the fulfilment, without further control, of a general obligation ; and without this attestation, a foreign Government would have no possibility of knowing whether an aircraft were airworthy, except by carrying out its own examination of the aircraft.

Instead of the present system of control by the Government, of which the aim is to protect public order, the Aero Club of France wishes to substitute compulsory third party liability insurance, with the aircraft controlled by companies of surveyors, such as Lloyd's Register of Shipping, Bureau Veritas, etc. It would be for these companies to register the aircraft according to classes, dependent on their airworthiness, and these classes would serve as basis for the calculation of the premiums by the insurance companies. This procedure has been in usage for a long time in merchant shipping, but in that connection the classification is not only used for the computation of premiums for liability insurance, but also, and primarily, for insuring the actual vessels and their cargoes, for evaluating them in the case of a sale or a seizure,—thus for transactions which are of far greater significance to shipowners than the conclusion of a liability insurance is to private aircraft owners. For this reason it seems exaggerated—due reserve being made for a statistical examination—to expect of a classification of this nature, a decisive urge to improve the airworthiness of private aircraft. Moreover, it is also doubtful whether it would be cheaper for private flyers to have their aircraft controlled by private companies instead of by the State or organisations duly authorised by the State. Private companies would have to rely on the control fees in order to pay their entire upkeep, whereas a Government organisation has State Budget funds at its disposal, and does not have to pay its own way. Finally, it is not at all certain that private concerns would adapt themselves quicker to new developments than State organisations, or the ICAO. Although many a State official will stick to the old rules out of pure laziness classification companies often do the same because they have business reasons for wanting their quality standards kept high ; it costs them

a great deal to study new developments with their own research facilities, and if they can keep the proven regulations in force, they can guarantee a maximum of safety with a minimum of expense. Anybody who recalls Lloyd's formula for the crankshafts of marine Diesel engines, which remained valid until 1930 despite the existance of many calculation methods which were known to be more accurate, will not contradict this statement.

The French suggestion gives rise to a further, very delicate question, in that it maintains that private aircraft should be treated in a manner different from aircraft used in the commercial transportation of persons and freight. This distinction has something arbitrary about it, and could under no circumstances be made on the basis of the aircraft's characteristics. Alongside scheduled commercial air transportation, there exist the charter and taxi services—we have in mind those operated with medium-to-small sized aeroplanes—which do not require official licenses in all countries and which could easily be passed for private flights ; there are the flights with aircraft hired from clubs, but with paid pilots ; and there are the flights on which the amateur pilot to whom the aircraft belongs, allows his companions —paying guests—to share in the costs of the flight, of the aircraft, and even in his own travelling expenses . . . where must the line be drawn between the private aircraft and the small transport ? Likewise in motoring, foreign countries do not distinguish between hired and private automobiles, but prefer to see a certificate which mentions the weight of the vehicle and the efficiency of its brakes. Meanwhile, if it did become possible to set this limit, then the authorities could easily, and quite legitimately, render certain regulations more severe for small-traffic air operators, and less severe for private flyers —which would certainly not be to the detriment of passengers' safety, though definitely a cause for animosity between commercial and private aviation.

Any measure likely to free aviation of red tape is bound to find a universal welcome ; but we have all the less right to forget that private flying is not an end in itself, but on the one hand a school which must give forth conscientious, mature pilots, and on the other hand, a freer kind of aviation. In deciding whether a fundamental, and not merely a formal, slackening of the regulations relative to private aircraft would constitute an advantage from these two viewpoints, we must bear in mind the interests of aviation in its entirety and its rôle in our civilisation.

T.

The Air Hostess Told Us ...

. . et omnia vanitas !

Esmeralda, our favourite air hostess, blew in the other day to ask, how do you reduce someone else's weight ? It seems that some airlines are going a bit far in their attempts to flatter the vanity of female passengers. Of course, they have to be nice to the ladies, especially since American and Swedish figures show that housewives make up a surprisingly large proportion of the passenger volume (the last word is used advisedly). Nevertheless, it is difficult to see how ABA, the Swedish airline, will enforce their official plan of reducing the average weight of the ladies to 65 kilograms "in due course." As an immediate measure, ABA will "lower the average weight of adult passengers from 80 to 75 kilograms." The method to be employed is top secret.

Slimming Treatment.

Leaving ABA's plan entirely aside, our favourite air hostess claims that some drastic slimming measures were applied accidentally a few weeks ago. These were neither standard practice nor recommended. In the first case, the 62 passengers of the ill-fated "Bermuda Sky Queen" of American International Airlines, flying from Ireland to New York, received the shock of their lives when their flying-boat had to alight in mid-Atlantic owing to fuel shortage and, apparently, inexpert navigation. That they were let off "lightly"—nobody was injured —was certainly not due to the violation of CAB rules by this non-scheduled carrier, but to the sturdiness of the veteran Boeing 314, which withstood the terrific buffeting of mountainous waves, and the presence and helpfulness of the U.S. weather ship "Bibb."—Cheers for the American sailors and for the International Civil Aviation Organisation which about a year ago had the glorious idea of arranging for thirteen weather ships to be stationed all over the Atlantic.

The second case was that of a Douglas DC-4 of American Airlines, which was peacefully winging its way with 48 passengers from Dallas to Los Angeles. Over Mount Riley, in Texas, the aircraft suddenly went into a climb, then into half an outside loop and was righted only about 400 ft. above ground. During its antics, passengers and belongings floated around the cabin "like feathers," a Frenchman was doused with the contents of the chemical toilet (according to "Time" magazine, he was subsequently assured that "this was not normal operating procedure"), and the heads of the ladies were turned into something resembling moulting South American water fowl. The aircraft itself received "minor damage . . . from the passengers striking the lining of the cabin . . ." It was discovered that this weird behaviour had been occasioned by one Charles Sisto, senior pilot of A.A., who was making the flight as a check pilot and has meanwhile "been resigned." He had suddenly experienced an irresistible urge to find out what would happen if he put on the gust lock in flight, without informing the two other pilots . . . That the experiment did not end in disaster is the merit of the co-pilot and the sturdiness of the DC-4.

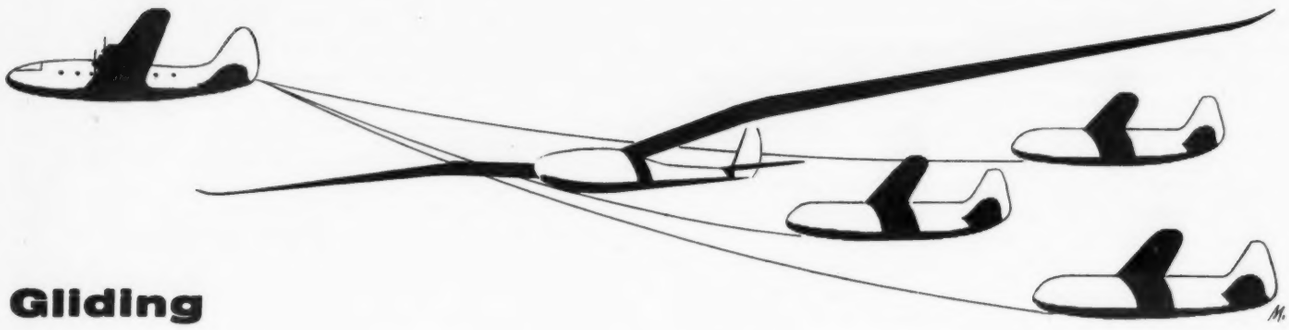
Occurrences like these are inadmissible because they are avoidable. Both near-catastrophes show that discipline of the air still needs improvement. Irresponsible people should not be given a chance of playing with the lives of 62 or 48 or even one passenger. Unfortunately it is true, technically speaking, that some airline accidents are still caused by a nut that holds the wheel.

Still going strong . . .

On August 9th, the U.S. Air Force announced there was "insufficient evidence" that the much-discussed flying saucers of last summer ever existed. In spite of this denial, the flying objects are still going strong. So it was reported from the Emmental, in Switzerland, a valley inhabited by an especially slow-moving mountain people, that a flying disc had just been sighted. Esmeralda suspects, however, that the disc in question was merely one of the famous Emmental cheeses gone slightly high.

At the end of October, renewed reports from Denmark announced the appearance of a novel type of flying hardware, namely, flying bottles. Our favourite air hostess hopes that they are corked and untouched and bear lables saying, for example, something about Johnny Walker still going strong. On the other hand, the bottles may merely be soda-water syphons that slipped out of somebody's hand and now career, jet-propelled, through the skies. The sad aspect of the thing is, of course, that they will only fall when they are quite empty. But even full, Esmeralda says, she'd only use them for watering the aspidistra.

Bl.



Gliding

Our new regular feature

Time and time again we have received letters from readers of many nationalities, all asking the same question : "Why do you never mention gliding in your magazine ?" We were well aware of the justification of this question and of the importance of the subject ; but we were at a loss for a person to whom we could entrust the writing of a regular feature on gliding. Just any young gliding enthusiast might, perhaps involuntarily, have treated it from the viewpoint of sport and justified national opinion, and consequently missed the mark as regards the overall picture, the real subject of gliding. From the start we had to have a guarantee that such a regular feature would be of value consistent with the quality of our magazine.

This month carries the initial article by our *new contributing editor on gliding, an internationally-recognised expert : Squadron Leader Robert Kronfeld, A.F.C., A.F.R.Ae.S.*

Allow us to introduce him.

Robert Kronfeld has had a most varied and distinguished career in aeronautics. Little was heard about him during the War ; in fact the rumour was circulated in some neutral countries that he had been killed in action whilst serving in the R.A.F. Happily, this was not true. In reality, the man who had been in the limelight of glider development had become one of the "back room boys," one of the technicians and scientists who, away from the spectacular scenes of battle, helped in utmost secrecy to develop the "tools" for the Allied victory.

S/Ldr. Robert Kronfeld, A.F.C., A.F.R.Ae.S.

Many people did not meet him again until last September when, at the Display of the Society of British Aircraft Constructors at Radlett, he demonstrated one of the three tailless research gliders built by General Aircraft, Ltd., for the Directorate of Scientific Research, Ministry of Supply. At heart, Kronfeld was still a glider pilot.

Born in Vienna in 1904, he has made his home in England. His flying capacity is backed up by a sound training in aerodynamics, mechanical engineering and meteorology, which he received at the technical colleges of Vienna and Darmstadt. Having learned to fly gliders in 1926 at Rossitten, East Prussia, he used to spend his student vacations at the advanced gliding school at the Wasserkuppe, Rhön.

In 1929 he won his first prize, offered for the first to fly one hundred kilometres in a glider. This was soon followed by six world records, and in the same year he took up aeroplane flying. He was awarded the No. 1 International High Performance Gliding Badge. Also during 1929, he organised the first glider research expedition into the Austrian Alps.

In 1930 he went abroad. With his sailplane, "Wien," Kronfeld accepted an invitation of the newly-formed British Gliding Association, under whose auspices he demonstrated gliding in all its aspects, sharing his experience with his hosts. A wing failure in his new glider, the largest single-seater built at the time, compelled him to bail out in 1931, but this did not prevent him from winning, in the same year, the £1,000 prize offered by the *Daily Mail* to the first pilot to cross the English Channel both ways in a glider.

Then, less was heard about him until he re-appeared in the ranks of the Allied air forces, which indeed followed his example by using gliders to cross the sea-barrier between England and the Continent.

When the Nazis began to set foot in Austria in 1933, Kronfeld severed his connections with the Austrian Government, to whom he had acted as aviation adviser, and accepted posts as consultant to the French, Italian and Swiss Governments. Going a step further, he decided to try his hand at developing "foolproof" ultra-light aeroplanes. Consequently, he became founder and director of the British Aircraft Co. (1935) Ltd., at Feltham, near London, and later of the Société Française d'Aviation, Paris. Respectively, these two firms built the "Drone" and "SFAN" light aeroplanes. But the War was drawing nearer, and in 1937 Kronfeld was appointed Chief Instructor and General Manager of the Oxford University Gliding Club.

Having become a naturalised British subject, he offered his services to the Air Ministry at the outbreak of war, and was commissioned in the R.A.F. in 1940. Throughout the hostilities he served in the Airborne Forces Experimental Establishment of the Ministry of Aircraft Production and Supply as Senior Technical Officer and Test Pilot with the rank of Squadron Leader. In this capacity he was given the highly-important task of testing all the new types of British and U.S. military gliders destined for airborne troop operations.

Today, glider-pilot Kronfeld can look back upon over 7,000 hours' flying experience. Besides the Golden Order of Merit conferred upon him by the Austrian Government in 1933, he also holds the Air Force Cross, which he was awarded in 1944 in recognition of his work for the R.A.F. The records reveal a number of patents to his name, which for a long time remained secret.

Since the War and his demobilisation, Kronfeld has been flying prototype gliders with and without power plant. In this capacity, too, he is still acting as a research scientist and test pilot for the Ministry of Supply.

Books by and on Kronfeld have been published in several languages.

Our readers may look forward to his contributions.

The Editor.

Gliding Today

By S/Ldr. Robert Kronfeld, London.

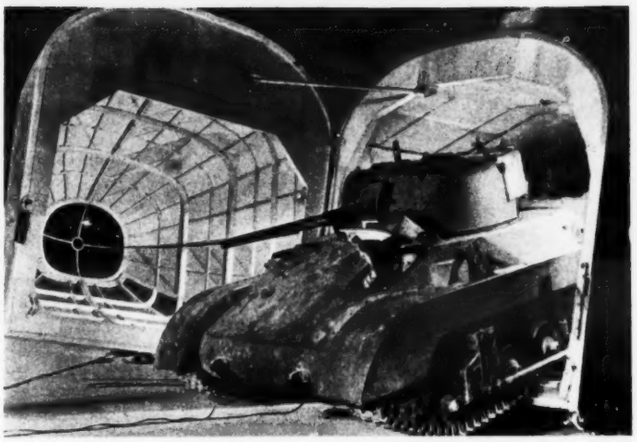
Just as the first World War advanced the development of aeroplanes, the second World War fostered gliding technique and greatly assisted the development of transport and research gliders.

In 1939 Hitler unleashed, on the rest of mankind, his war of nerves by boosting his secret weapons. It is interesting to recall that his secret weapon No. 1, used to enforce the surrender of the brave garrison of the vital Belgian frontier fortress, consisted of a force of military gliders which, carrying specially-trained assault troops, landed on top of the fortifications in a surprise attack.

The Allies, at that time, possessed no military gliders, engineless flight having been considered purely as a sport for enthusiasts. The more remarkable, therefore, is the fact that Britain, hard pressed as she was during the War, managed to design, develop and produce a whole fleet of military gliders which, while thoroughly practical, were capable of carrying greater loads, were better equipped and, as the final victory proved, more successfully used than the German glider forces. Britain built the Airspeed "Horsa," which proved its worth as a large troop transport glider, and the "Hamilcar," a successful

transport for heavy military equipment, which could take two Bren-gun carriers or even one tank. The U.S.A. contributed to the Allied effort by mass-producing the CG-4A, a smaller glider designed to carry a Jeep. It is thanks to the quality of this equipment and the spirit of the men who used it, that the Allied glider operations met with such success in Sicily and Normandy, and in the final crossing of the Rhine. Compared with this, the previous use by the Germans of engineless aerodynes in Belgium and later in Crete was a relatively small achievement.

Of far-reaching consequence for the future of air transport was the development of the pick-up method during the war, carried out by the late Richard C. Dupont in the U.S.A. In the field of rotary-wing gliders should be mentioned the rotorkite used by German submarines for observation purposes. Recent British and U.S. publications reveal that engineless scale models of future aeroplane types, including such of the rotary-wing and tailless variety, were used for research purposes during the War.



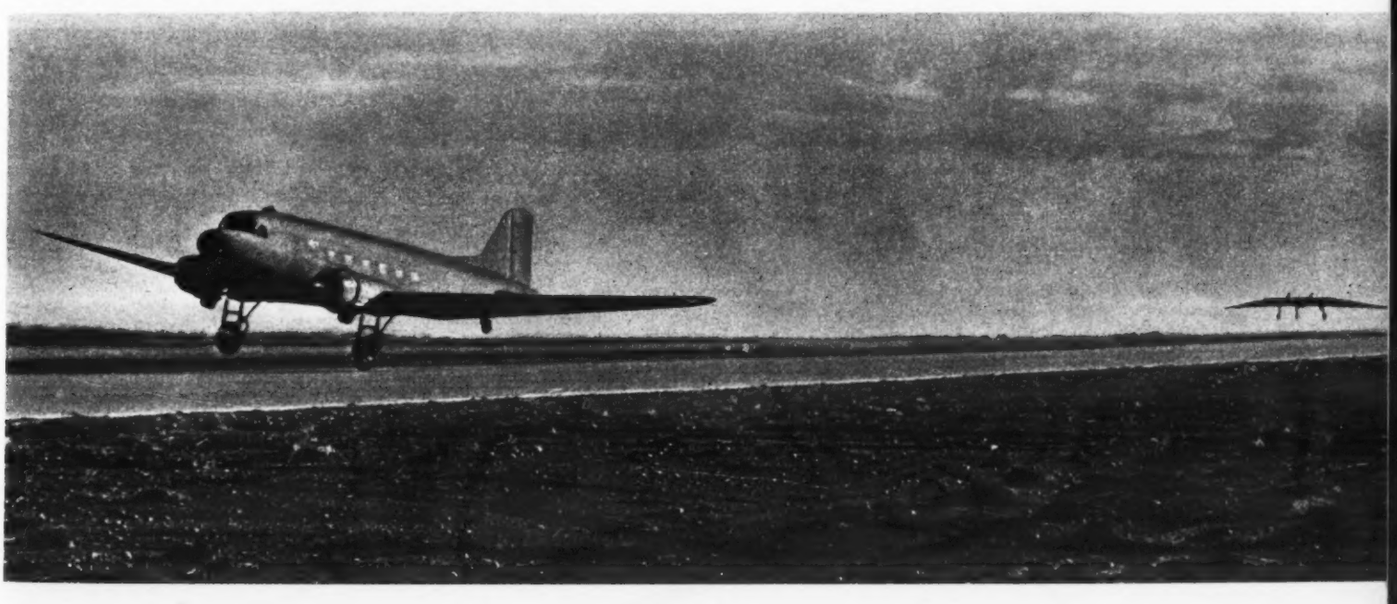
The British "Hamilcar" glider, suitable for transporting a tank.

Now that peace-time aviation has made a fresh start, where do we stand with regard to gliding ? The distance record is 512 miles ; single-seater sailplanes have stayed 56 hours in the air, and an altitude of 36,000 feet has been reached. These performances are remarkable enough, but we know that, under favourable conditions, thunder-fronts and even standing waves may extend over many hundreds of miles. If, therefore, flights could be continued through the night, even the single-seater distance record could be doubled, or trebled, and two-seaters could follow fronts over entire continents. There are scientific foundations to the speculation that the altitude record might be doubled, and that the present-day absolute World altitude record, established with an aeroplane, could be broken by a sailplane fitted with a pressure cockpit. For single-seater duration, the limits of human endurance seem to have been reached. Meanwhile, however, nothing except boredom stands in the way of a two-seater's remaining airborne for several days, possibly weeks, provided the pilots did not run short of up-wind, or of food and drink ; so we see that there is plenty of opportunity for record enthusiasts.

The future of gliding as a popular sport is secure. This can best be seen from the uninterrupted development in countries where it is not subsidised. While the old controversy about the value of gliding as an instructional method prior to military and transport flying is still going on, most countries seem, at one time or another, to have made experiments in training their future airmen "the glider way" ; this in spite of the fact that (very surprisingly) no one has so far designed a suitable training glider which, while foolproof, is at the same time as sensitive and manoeuvrable as a training aeroplane. As we have seen, the success of military gliders has been such that they should play an important part as expendable transport equipment for many years to come. The war-time developments were rushed ; only now will designers have time to plan for maximum performance. Pick-up technique, still somewhat in its infancy, has made it possible for gliders to take off in a very small space, and powerful flaps and air brakes enable them to land in such a short distance that, in certain circumstances, they can be used successfully in conditions where only helicopters can compete.

So far no commercial airline company has used gliders for passenger or freight transport. This appears to be due not so much to performance considerations as to the fact that tug-glider combinations are more adversely influenced by bad weather conditions than aeroplanes alone, and are more difficult to handle on the ground. However, the

Launching the Canadian tailless research glider at Namao airfield, Alberta.



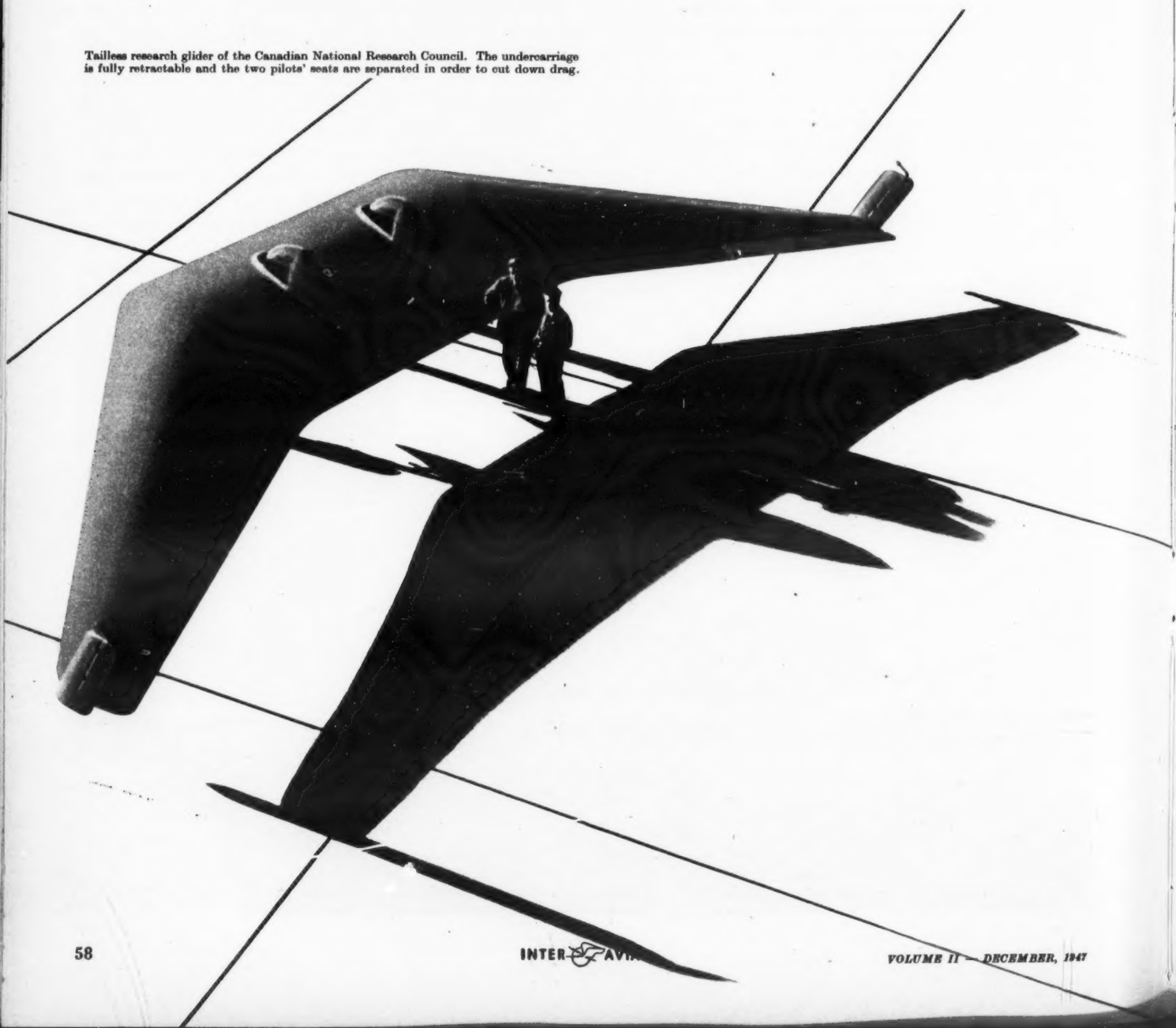
Two research gliders built by General Aircraft, Ltd., exhibited at the S. B. A. C. Display, Radlett, 1947.

last decision in this sphere has not yet been made, and small changes like, for example, the use of solid tow bars instead of tow ropes, as developed by the Germans during the War and recently demonstrated in the U.S.A., may alter the picture overnight.

The work of glider experimental establishments of all nations during and since the War, has provided a large reservoir of knowledge and experience ; and this alone will supply development and research workers with material for a long time to come. For obvious reasons the publications in this field are scarce. Meanwhile, the heavy-type glider as an instrument of aerodynamic research has, however, been demonstrated to the public. These are gliders of 3,000 to 5,000 lbs. all-up weight and usually equipped with automatic recorders. In this way Professor G.R.T. Hill developed his "Pterodactyl" many years ago, and lately inspired the development of the tailless glider of the Research Council of Canada. Similary, by first building model gliders, Lippisch developed the Messerschmitt Me. 163 rocket fighter ; Northrop, in the U.S.A., his eight-jet B-35 ; and Armstrong Whitworth, in England, the twin-jet A.W. 52. To these individual and remarkable achievements should be added the work of General Aircraft, Ltd., on research gliders for the Ministry of Supply.

Gliding has, as can be seen, outgrown the sports stage, and apart from young enthusiasts and scientists, most air force and military authorities, as well as the designers of some of the world's greatest aircraft manufacturing companies, have considered glider projects of one form or another. It shall be the object of this column to deal with the various aspects of this interesting branch of aviation.

Tailless research glider of the Canadian National Research Council. The undercarriage is fully retractable and the two pilots' seats are separated in order to cut down drag.



Official Bulletin of the F.A.I.

Fédération aéronautique internationale, Paris.

Commission d'Aéronautique Sportive Internationale

Report on the Commission's Work, September 15th, 16th, 17th, 1947.

New Regulations for Speed Records over a 3-km. Course, Distance Records in a Straight Line, and Altitude Records

The following text has been definitely adopted by the commission : [1]

I. Conditions Applying Jointly to All Three Records

1. Obligations.

(a) At least sixty days before any attempt on one of the records in question (speed over a 3-km. course, distance in a straight line, altitude), the national aero club concerned shall submit to the F. A. I. a report containing a detailed description of the arrangements made for controlling the record attempt, for executing the prescribed observations and measurements, and for verifying whether all the required conditions have been fulfilled. The attempt must take place within ninety days after the report has been sent in.

If it does not take place within this delay, a new inscription must be made, which shall precede the new attempt by at least sixty days. Each inscription must be despatched by telegram at the moment the report is sent. The report itself must be transmitted to the F. A. I. through two different channels.

(b) The F. A. I. shall designate a representative whose rôle will be to observe the control of the record attempt, and it shall inform the competing aero club accordingly.

(c) The competing aero club shall send a copy of the report mentioned in the above paragraph *(a)*, to the representative designated by the F. A. I., and shall point out to him the proposed date of the record attempt. These indications must reach the F. A. I.'s representative at least thirty days before the anticipated date of the record attempt.

(d) The thus designated observer shall be regarded as a "*commissaire sportif*" in accordance with the *règlements sportifs* of the F. A. I. The competing aero club shall grant him every facility for observing the control of the attempt and so that he may be able to assure that all the regulations are properly applied. He shall act as an "honorary observer," but all justified expenses shall be reimbursed him by the competing aero club.

(e) If the representative designated by the F. A. I. should not be able to assist at the attempt and control its execution, this absence, in itself, shall not invalidate the record attempt, provided that all the other conditions have been fulfilled.

(f) Within sixty days after execution of the record attemp, the national aero club concerned shall send the F. A. I. a complete report describing in detail all the arrangements made for controlling the record attempt, for carrying out the prescribed observations and measurements, and for verifying whether all the required conditions have been fulfilled. This report must comprise signed certificates, stating the measures taken for assuring the precision and exactitude of the methods used ; it shall indicate, moreover, the probability of error for all the measurements concerning the verification of the record attempt. These estimates shall be guaranteed by one or several scientific organisations, particularly qualified in the opinion of the national aero club. In cases where photographs or other visual recordings of the measurements have been used, the originals shall be enclosed along with the official report. The report shall be signed by the *commissaires sportifs* agreed upon for the control, including the observer (if there is one) mentioned in the preceding paragraph.

(g) The F. A. I. reserves the right to demand that it be supplied with supplementary proof showing that the regulations have been properly observed ; it shall have the right to refuse the homologation, should it consider the proof furnished to be insufficient.

2. Safety.

In order that it may be permitted to make a record attempt, every aircraft must be provided with : *(a)* a certificate of airworthiness conforming to the international conventions, *(b)* an attestation of airworthiness (established in writing) delivered by the aeronautical authority of the country to which the competing national aero club belongs, or *(c)* a certificate stating that the aircraft has been accepted, either for experimental purpose or for general use, by the Government authority of the country concerned. This certificate or this attestation must cover the utilisation of the special devices used in accordance with paragraph 3.

3. Special Devices.

Special devices, including jettisonable tanks, for facilitating take-offs and landings, or for improving the performance in flight, are authorised under the condition (A) that their details are described in the report mentioned in paragraph 1 *(a)* above, (B) that their utilisation is covered by the attestation mentioned in paragraph 2, and (C) that any device for facilitating the take-off and landing is used during the test flights mentioned in paragraph 4. The special devices may be jettisoned in flight ; however, their jettisoning must occur prior to the first passage over the measured course. All methods of assisted take-off are authorised.

4. Test Flights.

Before executing a record attempt, the aircraft and the pilot must have effected at least two take-offs, circuits and landings, without damage to the aircraft and pilot (apart from very insignificant damage to the aircraft, repairable within twenty-four hours). For these test flights, the aircraft must be in exactly the same condition as for the record attempt ; it must be fitted with all the equipment intended for use in the attempt, and employ all the special devices for facilitating the take-off and landing, mentioned in paragraph 3. It is all the same not necessary that it carry the entire load foreseen for the record attempt.

5. Accidents.

As a general rule, the F. A. I. shall not homologate a record if, during the attempt, an accident occurs which causes the death of one of the crew members during the forty-eight hours following the accident or if, during the attempt, the pilot or a member of the crew abandons the aircraft. However, the F. A. I. may, at its own discretion, homologate a record if it is convinced :

(a) that the performance was accomplished prior to the accident or the abandoning,

(b) and that the accident or the abandoning are to be ascribed to a *force majeure*, and not to a lacking of airworthiness or an error of control of the aircraft.

6. Pilotless Aircraft.

No pilotless aircraft shall be allowed to compete for any of these different records. The utilisation of an automatic control device is authorised for facilitating flight or navigation, but a pilot responsible for the aircraft must be on board throughout the entire period of the record attempt.

7. Precision of Measurements.

The stipulation that the precision of the measurements must be inferior to a certain margin (x), signifies that the probability of an error superior to x must be smaller than one per cent.

[1] Translated by Interavia. The original French text only is officially binding.

II. Regulations for Speed Records over a 3-km. Course

1. Course.

The length of the course shall not be inferior to three kilometres ; it shall be prolonged at each of its extremities by a run-in and run-out strip of at least 1,000 metres. The course must be measured to within a tolerance of at least 1/50,000.

The measured course and the run-in and run-out strips shall be indicated sufficiently clearly to enable the pilot, and the *commissaires* situated at the extremities of the course, as well as at the points of departure and arrival, to distinguish them easily. The methods of limiting the course are left to the discretion of the national aero clubs interested, but must obtain the approval of the F. A. I.

The length of the course shall be measured with such precision that the speed of the aircraft over the course, taking into account the accuracy of the process used for timing, shall be obtained to within a tolerance of plus and minus two kilometres an hour.

It shall not be necessary that the measured course be homologated in advance by the F. A. I., but its characteristics (or those of other courses which could be used) must be communicated to the F. A. I. at least thirty days prior to the attempt. The F. A. I. shall have the choice of not accepting the proposed courses, either prior to the attempt if the intended methods of measurement and timing do not appear to be sufficiently exact, or after the attempt if the outside observer designated by the F. A. I. reports that the methods actually employed for measuring and timing do not embody the required accuracy.

2. Flight Altitude.

The maximum flight altitude over the course shall be 100 metres, and the maximum altitude throughout the entire duration of the flight shall be 500 metres.

3. Speed Measurement.

The aircraft shall fly over the course twice in each direction, and the speed considered shall be the average of the four speeds, approximated to the nearest kilometre-per-hour.

The timing shall be accurate to within 1/500 th. of a second. If more than two runs in each direction are effected during the same flight, any four consecutive runs may be selected for submission to the F. A. I., under the condition that these four runs have been accomplished alternatively in one or the other direction.

The four selected runs must have been accomplished within an elapsed time of thirty minutes.

III. Regulations for Distance Records in a Straight Line

1. Course.

For records of less than 15,000 kilometres, measured in accordance with the rules stated below, the competitor may change course once during a flight, at a point designated in advance, referred to hereafter as the turning point *(point de virage)*. The change in course shall not exceed 90 degrees, and one of the two sections of the course must not be shorter than 10,000 kilometres.

For records of over 15,000 kilometres, the competitor may change his course as many times as he desires, at points designated in advance and referred to hereafter as turning points, provided *(a)* that no change in course exceeds 90 degrees, *(b)* that at least one of the sections is 10,000 kilometres or more, and *(c)* that all other sections, except for the first and last ones, are not less than 5,000 kilometres.

2. Points of Control and Recognition of the Aircraft.

The point of departure, all turning points, and the point of arrival, shall be points of control. Supplementary points of control may be established at the wish of the competitor or at the demand of the F. A. I.

Suitable methods shall be used for unambiguous identification of the competing aircraft at every point of control. Data on the proposed method or methods of identification shall be sent to the F. A. I. at least thirty days before the record attempt, and the F. A. I. shall have the right to withhold its approval of any attempt for which adequate methods of identification have not been foreseen.

Observers provided with suitable equipment shall be situated at all points of control excepting the point of arrival. These observers shall identify the aircraft as it passes the point of control, and record the date and hour by G. M. T. of the passage, as well as any circumstances capable of influencing the verification of the application of the present regulations.

The position of the point of arrival shall be established in an unambiguous manner by independent witnesses, failing which the point of arrival shall be considered as being the last point of control over which the aircraft was identified.

An aircraft shall not be disqualified solely because of a wreck at sea at the point of arrival, under the condition that this point can be established with accuracy.

3. Distance Measurement.

For records of less than 15,000 kilometres, considered shall be only the lowest of the results obtained by one of the following methods :

(a) calculation of the sum of the lengths of the great-circle arcs between the different points of control ;

(b) or 1.1-times the sum of the lengths of the great-circle arcs between the point of departure and the turning point, and between the turning point and the point of arrival, not taking into account the supplementary points of control.

For records of over 15,000 kilometres, considered shall be only the lowest of the results obtained by one of the following methods :

(a) calculation of the sum of the lengths of the great-circle arcs between the different points of control ;

(b) or 1.1-times the sum of the lengths of the great-circle arcs between the point of departure and the first turning point, between the successive turning points, and between the last turning point and the point of arrival, not taking into account the supplementary points of control.

In the two cases, the lengths of the great-circle arcs shall be taken at sea level and calculated in accordance with the conditions adopted for the standard ICAO 1-to-1,000,000-scale map of the world.

The length of each great-circle arc shall be calculated to within a tolerance of 1/50,000th.

4. Miscellaneous.

Each new record must be superior to the preceding one by at least 100 kilometres.

Refuelling in flight between the point of departure and the point of arrival is forbidden.

The aircraft shall not land between the point of departure and the point of arrival, and must remain in the air during the entire duration of the flight. Sufficient proof must be furnished that these conditions have been fulfilled.

IV. Regulations for Altitude Records

1. Measurement.

The maximum altitude attained may be measured by any recording method of well established accuracy, which does not yield a margin of error in excess of plus and minus one per cent.

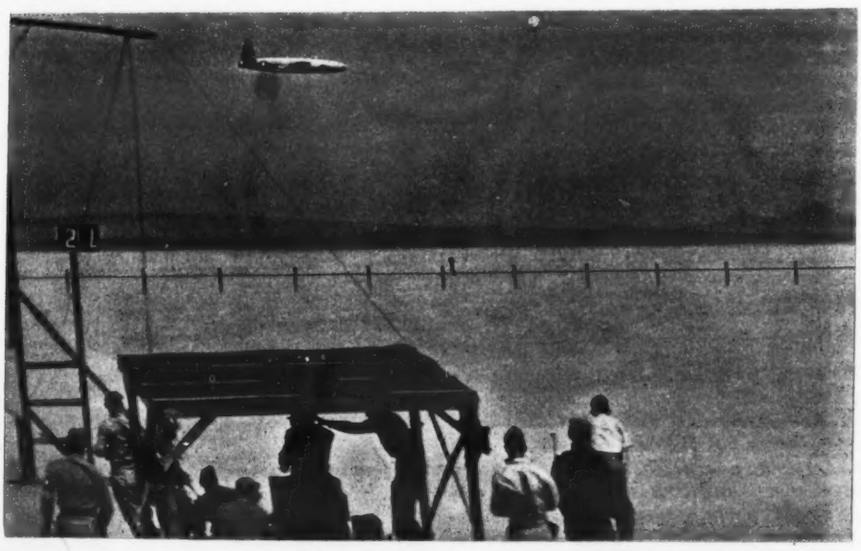
Details of the intended method of measurement shall be sent to the F. A. I. at least sixty days before the record attempt, and the F. A. I. shall have the right to withhold its approval of any method of measurement of which it shall not be proved that it conforms to the requirements mentioned above.

2. Margin.

The preceding record must be beaten by a margin of at least two per cent.

3. Reference Altitude.

Altitude measurements shall be based on sea level and under the conditions established by each country for its national cartography.



Timing a world speed record over a 3-km measured course. Photo shows Colonel Boyd's Lockheed P-80R "Shooting Star" breaking the 1,000-km/hr. mark for the first time officially on June 19th, 1947. This record has since been beaten with a Douglas D-558 "Skystreak."

THE MONTH IN REVIEW

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POLITICAL

● The Government of the Dominion of Newfoundland is considering a project under which *Newfoundland* would be incorporated in the *Dominion of Canada* as a tenth province. An important factor in the union are the air bases in Newfoundland and on the Labrador Coast (which forms part of Newfoundland). The principal Canadian acquisition would be *Gander Airport*, the well-known trans-Atlantic airbase on which the Canadian Government spent $15,000,000 during the War ; the Newfoundland Government subsequently bought the field back for $1,000,000. Other bases in Newfoundland territory are the flying-boat base at *Botwood*, the fighter field at *Torbay*, and *Goose Bay* airport in Labrador : the last two airfields are operated by Canada under 99-year leases.

● *Civil Aviation Agreements* have been concluded between Sweden and Yugoslavia, Sweden and Czechoslovakia, and Great Britain and Colombia.

NEW AIRCRAFT

● The prototype of the *Northrop YB-49* eight-jet all-wing bomber made its first flight on October 21st. Powered by eight General Electric TG-180 turbo-jets, each developing 4,000 lbs. maximum static thrust, this "flying wing" accommodates a thirteen-man crew, features a span of 172 ft. and weighs 200,000 lbs. gross.

Northrop YD-49 taking off on its first flight.

● The second prototype of the *SO 1100-02 " Ariel "* rotary-wing aeroplane built by *SNCA du Sud-Ouest*, is undergoing its flight test programme ; its first flight was made on October 15th at Suresnes. The aircraft can be used either as a helicopter or an autogyro, the free-wheel rotor being driven either by jet propulsion, with the exhaust gases compressed and ejected through nozzles at the blade tips, or by a pusher airscrew fitted at the rear.

● *Douglas Aircraft Company* is developing a twin-engined jet fighter, the *Douglas XF3D-1*, which is to be powered with two Westinghouse 24C turbo-jets of 3,000 lbs. static thrust.

● *Boeing Aircraft Company* is developing a heavy bomber designated the *XB-52*. Its power plant will comprise four airscrew turbines.

● *Curtiss-Wright Corp.* will only put its CW-32 four-engined cargo transport into production if sufficient orders are received. The aircraft only exists in mock-up form at present. The firm considers that a major difficulty in realising the CW-32 project is the lack of funds for the procurement of new military aeroplanes and the unstable economic condition of the airline companies.

● *Aeronautica Macchi*, of Varese, Italy, is working on the prototype of a twin-engined personal and light transport aeroplane, the *Macchi M. B. 314*, which may also be used as a trainer for navigational and instrument flying. The aircraft is to be a low-wing monoplane of wooden monocoque construction. Power plant will comprise two air-cooled four-cylinder in-line engines, in the 155-170 H. P. class. The estimated maximum speed is 186 m. p. h. at sea level ; cruising speed, 149 m. p. h. on 60 per cent. maximum power ; range, 995 miles for the four-seater version and 497 miles for the six-seater version.

● *Otrokovice*, the Czechoslovak Government-owned aircraft manufacturing concern, is developing a new two-seater trainer, the *Zlin 26*. The firm is also bringing out a new version of the *Zlin 181*, to be known as the *Zlin 381*. (The former model is derived from the German Bücker Bü 181.) The Zlin *381* is powered by a Walter Minor 4-III air-cooled four-cylinder in-line engine of 105 C. V. *Chocen*, another Czech nationalised concern, is developing the *Mraz M-2 and M-3*, the M-2 model not being a new design, but merely a two-seater version of the Mraz M-1 " Sokol " personal aeroplane. The M-2 is powered by a Zlin " Persy III " air-cooled flat-four of 65 C. V. — The Mraz M-3 is a four-seater personal aeroplane with retractable tricycle undercarriage. It can be powered by either a Walter " Minor 6-III " air-cooled six-cylinder in-line of 160 C. V., or by a Praga air-cooled flat-eight of 150 C. V.

● Although the *Instituto Aerotécnico de Cordoba* designed the *I. Ae. 31 " Colibri "* two-seater trainer, the Cordoba firm of *H. Governa* is building the prototype. The " Colibri " is a cantilever low-wing monoplane built of wood and metal. Its development was started in December, 1946, and the machine took to the air for the first time on September 15th, 1947. Power plant consists of a Cirrus " Major III " air-cooled four-cylinder in-line of 155 H.P., driving a two-blade airscrew with mechanically-operated pitch control.

I. Ae. 31 "Colibri."

POWER PLANTS

● *Société Rateau*, the French turbine specialists, have developed a turbo-jet designated the *Rateau-Anxionnaz SRA-1*, which was ultimately built by SNECMA, the nationalised aero-engine manufacturers. Test runs have hitherto been restricted to bench trials, but actual flight tests are to be started shortly.

● On October 10th the *Rolls-Royce " Dart "* airscrew-turbine started its flight test programme. Four days later, on October 14th, similar trials started with the Armstrong-Siddeley " Mamba " gas turbine. The flight-testing of both of these power plants has been carried out with specially-converted Avro " Lancaster " bombers. Meanwhile, the tests of the *Napier " Naiad "* airscrew turbine developed by D. Napier & Son, Ltd., are also well advanced.

Avro "Lancaster" with "Mamba" airscrew-turbine installed in nose.

INDUSTRIAL

● During the month of October, Vickers-Armstrongs, Ltd., delivered the 21,767th and last " *Spitfire.* " It was a " Spitfire XXIV, " featuring a maximum speed of 450 m.p.h. against the 260 m.p.h. of the " Spitfire I. " The " Seafire, " naval version of the " Spitfire, " is still in full production.

● It is planned to produce 100 units of the *Aero 45* twin-engined four-seater light transport at the nationalised Czechslovak plant of *Vysocany*. A total of 20 to 30 *Praga E 211* twin-engined four-seater aeroplanes are to be built next year by the nationalised *Karlin* concern.

Praga E 211.

RESEARCH

● *North American Aviation, Inc.*, plans building a second *supersonic wind tunnel*, which will be considerably larger than the one now in operation. The new tunnel is also to be of the open-type design, and is destined primarily for research on models of guided missiles. A test chamber is to have a cross-section measuring 16 in. × 16 in., and should be capable of simulating speeds from 1,150 to 3,400 m.p.h. The tunnel will be operated on an intermittent basis, the average period of operation being 15 seconds, with seven runs an hour.

INTERNATIONAL ORGANISATIONS

● *ICAO :* On November 1st the General Assembly of the United Nations approved applications by *Austria* and *Italy* for membership of the International Civil Aviation Organisation. — The Government of *Haiti* has ratified the International Civil Aviation Convention and will shortly deposit the instrument of ratification in order to become a member of ICAO.

● *IATA :* The International Air Transport Association has admitted the following airline companies to

* Excerpts from Nos. 1373-1384 (October 14th to November 8th, 1947), of "Interavia, International Correspondence on Aviation," an illustrated newsletter published thrice weekly in four languages English, French, Spanish and German.

membership of IATA: British Commonwealth Pacific Airlines, Central African Airways, Compagnie Belge de Transports Aériens (COBETA), Aerovia Brasil and *Aerlinte Eireann Teoranta.* There are now 69 airlines affiliated to the Association. At the *third Annual General Meeting* of IATA in Rio de Janeiro, it was decided to hold the next Annual General Meeting in Brussels; *Gilbert Périer,* of the Belgian SABENA, was elected *President of IATA for 1948.*

AIR TRANSPORTATION

● In the eight months ended August 31st, 1947, the *IATA Clearing House* had a turnover of $7,399,411. The following is the complete list of members of the Clearing House on November 1st, 1947: *Dollar Zone:* American Overseas Airlines, Pan American World Airways, Panagra, Panair do Brasil, Philippine Air Lines, Trans-Canada Air Lines, and Trans World Airline; *Sterling Zone:* The Swedish ABA, the Irish Aer Lingus Teoranta, Air France (temporarily unable to use the Clearing House for accounts with dollar zone operators), BEAC, BOAC, BSAAC, the Danish DDL, the Norwegian DNL, Indian National Airways, KLM Royal Dutch Airlines, the Belgian SABENA, South African Airways, the Swedish SILA, and West African Airways. Accounts of Scandinavian Airlines System are cleared through DDL, DNL and SILA.

● Denmark's and Europe's oldest airline, *Det Danske Luftfartselskab (DDL),* celebrated its *29th anniversary* on October 29th.

● The seven Douglas DC-4's of *Scandinavian Airline System (SAS)* flew a total of 2,911,500 miles, transported 16,165 passengers, 845,730 lbs. of baggage, 521,700 lbs. of freight and 265,340 lbs. of mail in the 12 months ended September 30th, 1947, which was the Nordic airline group's first year of scheduled service.

● *Det Danske Luftfartselskab* is scheduled to make a proving flight in November, as the last stage in the preparations for a *Copenhagen-Frankfurt-Geneva-Rome-Athens-Istanbul-Ankara* service; it may also go on to Damascus and Baghdad. Once services have been started on the Near East route, DDL plans opening a service to *Madrid and Lisbon,* probably also via Geneva.

● At the beginning of October, the Finnish *Aero O/Y* started its first post-war services abroad. It operates a non-stop *Helsinki-Stockholm* service each weekday with Douglas DC-3's, as well as a weekday service with Junkers Ju 52's from *Helsinki* along the existing domestic route by way of *Abo* and *Mariehamn* to *Stockholm.*

● On November 6th, a Douglas C-54 of *KLM Royal Dutch Airlines* took off on a *proving flight from Amsterdam to Teheran* via Rome, Athens, and Baghdad. The return flight was scheduled for November 12th and was to be routed via Ankara, Istanbul, Rome and Paris. The arrangements for this special flight were made by the Managing Director of Iranian Airways, the American-Iranian airline, when he made a personal visit to the KLM management in Holland.

● *KLM Royal Dutch Airlines* will re-route its twice-weekly service to *South America* from November 18th as follows: the Tuesday service from Amsterdam will be re-routed via Rome and Casablanca, thus giving Italy a direct KLM service to South America. The second weekly service to Rio de Janeiro and Montevideo, leaving Amsterdam on Saturdays, is routed via Lisbon, Dakar and Natal, as hitherto.

● The Civil Aeronautics Board stated on October 30th that *Swissair* had been granted a foreign carrier permit to operate services between *Switzerland and New York* via Shannon, Santa Maria and Gander.

● At the beginning of November *Air France* opened a through service from the *United States to Palestine* with only a two-hour stopover at Orly Airport, Paris.

● The *Italian civil aviation* authorities have received requests from 110 air operating concerns desiring to operate freight and taxi services, etc., on a non-scheduled basis.

● On October 30th, *British South American Airways Corp.* introduced a third service from London to the Caribbean with *Avro "Tudor IV's."* The "Tudor IV" service will normally follow the *London-Lisbon-Azores-Bermuda-Nassau-Havana* route; the first flight is continuing to Mexico City, where Air Vice-Marshal D. C. T. Bennett, the airline's Chief Executive, will hold discussions concerning regular services to that city.

● According to a Parliamentary statement, British Overseas Airways Corp. has concluded that the *Avro "Tudor I"* would be *unsatisfactory for the North Atlantic route,* as it has insufficient range to operate it on a regularity comparable with that of other services; it is uneconomical to operate and being a stop-gap aircraft, planned for use in 1946 but not available, it could not be expected to compare with other airliners specifically designed for the Atlantic. Sir Roy Dobson, Managing Director of A. V. Roe & Co., Ltd., stated that when the BOAC specification was first submitted, his firm had pointed out that the "Tudor I" could never be a commercial proposition.

● An arbitration award by the British Industrial Court has compromised between the demands of the British Air Line Pilots' Association and the offers of British Overseas Airways Corp. concerning *salaries and pensions for British air line pilots.* Pensions will consist of a fixed sum of £35 on retirement at the age of 40, rising to £650 at the age of 50. Minimum pay for pilots will range between £600 and £1,500 annually, according to grade.

● On October 28th, *Pan American World Airways* celebrated its *20th anniversary.* In 20 years of operation, PAA has carried over 7,000,000 passengers, 500,000,000 lbs. of mail and has made some 25,000 ocean crossings.

● The Civil Aeronautics Board announces that the *16 domestic scheduled airlines in the U. S. A.* suffered a *net operating loss of* $22,400,000 for the twelve months ended June 30th, 1947, against a net operating income of $12,700,000 for the previous twelve-month period.

● The Air Transport Association of America estimates that *U. S. airline operating expenses for 1947* will total some $55,000,000, over 100 per cent. more than the 1945 figure of $241,622,488.

● The U. S. Civil Aeronautics Board has proposed December 31st, 1950, as the deadline for the *retirement of the Douglas DC-3 from commercial air service.* Most of the U. S. airlines consider this as too early.

● The Civil Aeronautics Administration announces that there are a total of *1,998 irregular air carriers licenced in the United States.* They possess a total of 4,439 aeroplanes and 8,488 pilots.

● Under a scheme elaborated by the Air Transport Association of America and the Civil Aeronautics Administration, the airline traffic pattern between the two main New York airports, La Guardia Field and Newark, was changed on November 1st. *La Guardia* is the airport for *north-south flights,* and *Newark* is now used for most *east-west* flights.

● Time required for *landings at London's three main airports* in bad weather is to be limited to ten minutes for the entire landing sequence.

● Joy rides in Sweden have been forbidden until further notice in order to save fuel, for which "hard currency" is needed. This measure particularly affects the smaller companies, such as A. B. Ahrenbergsflyg, for instance, which specialises in joy rides. Of Sweden's total annual consumption of 198,000,000 Imp. Galls. of fuel, Swedish civil aeroplanes use some 3,520,000 gallons.

AIRPORTS

● *Czechoslovakia* has allocated Kc.240,000,000 for *airport construction and development in 1948* (a sum of Kc. 83,000,000 was allocated for 1947). *Ruzyne Airport, Prague* is to be expanded; *Ivanka Airport, Bratislava,* and *Turany Airport, Brno,* are to be re-equipped; *Barca Airport, Kosice,* and *Ostrava Airport, Ostrau,* are to be developed into international airports.—*Manises Airport, Valencia,* the first steel mesh runway in Spain has been brought into use temporarily, until the four hard-surface runways, 8,200 ft. long and 213 ft. wide, have been completed.—*Baghdad,* the capital of Iraq, is to have the most modern airport in the Middle East in 1948. It will cover an area of 2,470 acres and will cost 2,500,000 Iraqi dinars.

AVIATION PERSONALITIES

● *Rafael Martinez* has been appointed *Director of the Civil Aviation Department* of the *Spanish Air Ministry,* in succession to Juan Bono Boix.

● On October 21st, *Knud Gregersen,* Director of the Danish Civil Aviation Department, died. He had represented Denmark at numerous air conferences. His deputy, *Gustav Teisen,* a 55-year-old lawyer, has been appointed to succeed him.

SERVICE AVIATION

● Following one year of operations by the *USAF's 46th Reconnaissance Squadron,* the Air Force claims to have mastered the weather conditions in that area. Operating from Northern Alaska, the squadron flew some 1,000,000 miles during 5,000,000 hours in the air. More than 100 flights were made over the North Pole and its vicinity.

MILITARY PERSONALITIES

● *General of the Army Henry H. Arnold,* retired Commander of the USAAF, was presented with the Chinese Order of the Grand Cordon of Yun Hwei, Order of the Cloud and Banner, Special Class, on October 28th.

PRIVATE FLYING

● The *Aero Club of France* will hold an international *rotary-wing contest in 1949.*

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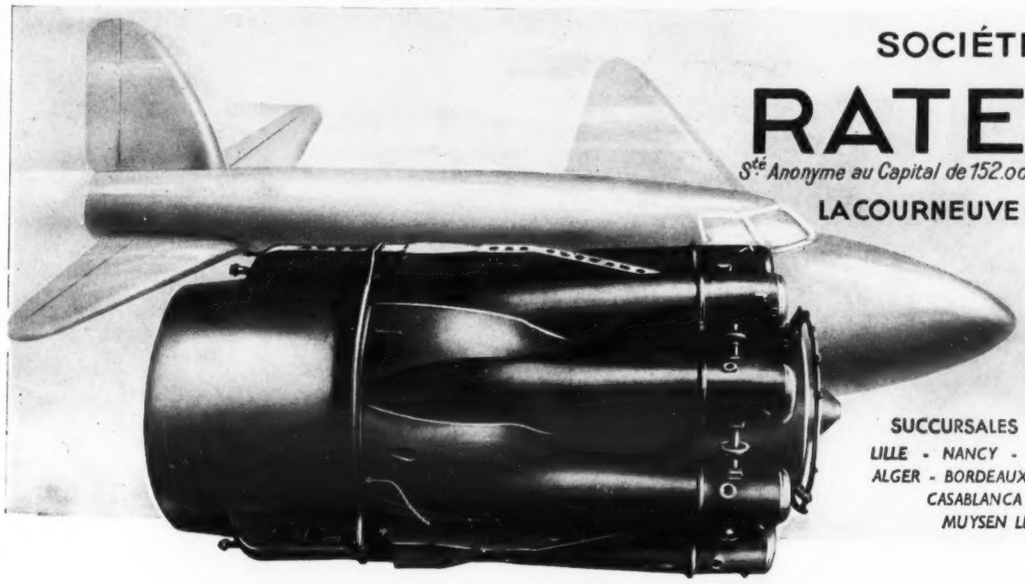

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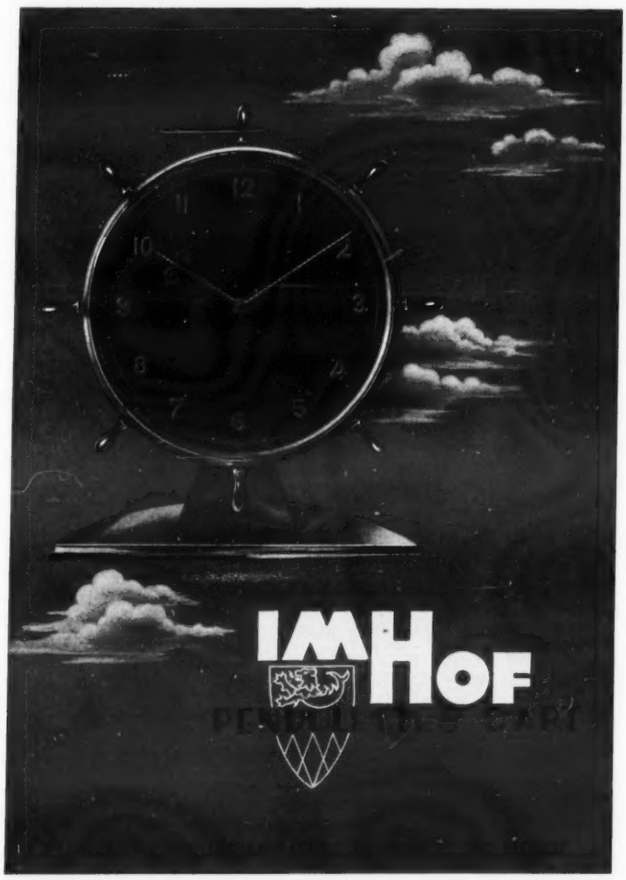

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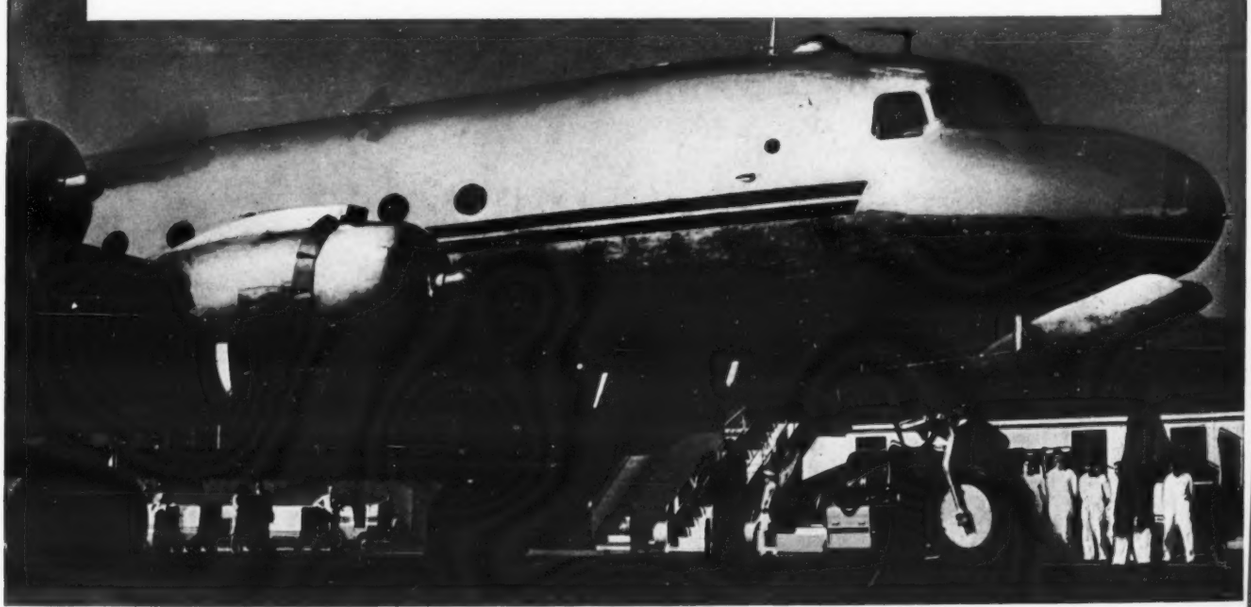
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